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PART V:

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

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COMMERCIAL DIVING STANDARDS

Proposed Standards and Hearing

DEPARTMENT OF TRANSPORTATION

Coast Guard

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COMMERCIAL DIVING STANDARDS

Notice of Joint Public Hearing

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

[29 CFR Parts 1910, 1915, 1916, 1917, 1918, 1926]

COMMERCIAL DIVING OPERATIONS

Proposed Rulemaking and Hearing

Pursuant to sections 6(b), 6(c), and 8(c) of the Occupational Safety and Health Act of 1970 (the Act) (84 Stat. 1593, 1596, 1599; 29 U.S.C. 655, 657), Secretary of Labor's Order No. 8–76 (41 FR 24059), and Title 29, Code of Federal Regulations (CFR) Part 1911, it is proposed to amend Subpart T of Part 1910 of 29 CFR by adding a new permanent occupational safety and health standard for commercial diving operations at §§ 1910.401–1910.441. In addition, pursuant to the above authority and section 41 of the Longshoremen's and Harbor Workers' Compensation Act, as amended (44 Stat. 1444; 33 U.S.C. 941) and section 107 of the Contract Work Hours and Safety Standards Act (83 Stat. 96; 40 U.S.C. 333), it is proposed to amend Parts 1915, 1916, 1917, 1918, and 1926 of 29 CFR by incorporating by reference the new standard for commercial diving operations which will appear at 29 CFR 1910.401 et seq.

The Act provides, among other things, that the Secretary of Labor:

> * * * in promulgating standards dealing with toxic materials or harmful physical agents under this subsection, shall set the standard which most adequately assures, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life.
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> In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be the latest available scientific data in the field, the feasibility of the standards, and experience gained under this and other health and safety laws. (Section 6(b)(5) of the Act, 29 U.S.C. 655)

This standard would apply to all commercial diving and related operations conducted in connection with all types of work and employments, including general industry, construction, ship repairing, shipbuilding, ship breaking, and longshoring, except for certain specified exceptions which are set forth below. The proposed standard includes requirements pertaining to the following subjects: personnel and medical qualifications, general and specific operations procedures, decompression table assessment, underwater work operations, diving equipment and systems, and recordkeeping and reporting.

The Occupational Safety and Health Administration (OSHA) requests the submission of written comments, data, and arguments from interested persons on all the issues raised by this proposal. In addition, pursuant to section 6(b)(3) of the Act, there will be an informal rulemaking hearing to provide further opportunity for the submission of evidence and discussion of the issues. The hearing will begin on December 16, at the time and place specified below.

At the rulemaking hearing, the entire proposed standard, including its scope and applicability, will be an appropriate issue for consideration. OSHA intends to present a number of expert witnesses to present evidence and to discuss major concepts incorporated in the proposal; it also invites public testimony and evidence relating to any of the issues raised by or related to the proposal. In addition, the issues of technological and economic feasibility, as well as any potential inflationary impact, of the proposal are appropriate for the presentation of testimony and evidence. After the hearing, OSHA will issue a final standard based on the full record developed in this and related proceedings. Details concerning public participation in this rulemaking proceeding are provided below.

I. Procedural History

A. *Emergency Temporary Standard.* On June 15, 1976, the Assistant Secretary of Labor for Occupational Safety and Health issued an Emergency Temporary Standard (ETS) for Diving Operations (41 FR 24272) as Subpart T of 29 CFR Part 1910, §§ 1910.401 et seq. It was issued pursuant to sections 6(c) and 8(c) of the Act, Secretary of Labor's Order No. 8–76, and 29 CFR Part 1911.

The background and reasons supporting issuance of the ETS and discussing its provisions were set forth in 41 FR 24272–24285, and are incorporated herein where appropriate. On August 8, 1975, a petition by the United Brotherhood of Carpenters and Joiners of America, AFL–CIO, was presented to the Secretary stating its belief that a situation of grave danger existed within the diving industry and urging that an ETS be issued with respect to diving operations to protect exposed employees. An informal fact-finding hearing was convened by OSHA in Washington, D.C., November 11–14, 1975. In conjunction with OSHA's evaluation of the data gathered during such hearings, a Federal interagency task force was assembled to provide technical support to OSHA with respect to a possible operational safety and health standard for commercial diving operations. Supplementing this effort, OSHA consulted with several independent diving experts on a number of subjects pertinent to the regulatory effort. Based on the evidence gathered, the Assistant Secretary determined, in accordance with section 6(c) of the Act, that divers were being subjected to grave dangers from toxic substances and harmful physical agents, as well as from new hazards, and that an ETS was necessary to protect the exposed employees from such danger. In particular, the Assistant Secretary found that commercial diving was an inherently dangerous occupation; that there was an almost complete absence of mandatory regulations to protect employees from the hazardous working conditions; that unsafe work practices existed within the industry; and that divers were being exposed to increased safety and health risks as a result of recent and anticipated diving activity at deeper depths.

The ETS was to have been effective on July 15, 1976. However, on August 11, the U.S. Court of Appeals for the Fifth Circuit issued an indefinite stay of the ETS pending a final decision on its validity, *"Taylor Diving and Salvage Co., Inc. et al. v. U.S. Department of Labor,"* Civil Action No. 76–2886 (CA 5, 1976). As of the date of this publication, the Court has not yet ruled on the merits of the ETS. Pursuant to the court order, the ETS has not been enforced by OSHA. For the reasons fully stated in a notice published this date (41 FR 48969), the ETS is being withdrawn.

B. *Development of the Proposed Permanent Standard.* To develop the proposal for a permanent standard, the Federal interagency task force was reassembled with representation from OSHA, the U.S. Coast Guard, the U.S. Navy, the National Institute for Occupational Safety and Health (NIOSH) of the Department of Health, Education and Welfare, the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, and the Smithsonian Institution. Individuals were assigned to the task force by their respective agencies for the purpose of providing technical and scientific support; as such, their participation was not intended to represent agency endorsements of the OSHA proposal.

In formulating this proposed permanent standard, OSHA has reevaluated the substantive provisions of the ETS in light of all the information relied on and referred to in the ETS and additional information made available to the agency since publication of the ETS. In addition to public comments which have been received on the ETS and recommendations from experts, other sources of information have included the final draft of a proposed standard and supporting technical narrative of the NIOSH-Undersea Medical Society-Tarrytown Labs, Ltd. project on "Recommended Medical and Operating Standards For Divers" (August, 1976), and the July and September 1976 "ballot" drafts of a proposed voluntary standard being developed by the American National Standards Institute's Z–135 Committee on Safety in Commercial and Industrial Diving Operations.

Inasmuch as many diving operations are closely associated with, or related to, construction activities, OSHA deemed it appropriate to seek the advice and recommendations of the Advisory Committee on Construction Safety and Health established under the Construction Safety Act (the Advisory Committee) prior to OSHA's formulation of a proposal. This step was taken pursuant to 29 CFR 1911.10 and 29 CFR 1912.3.

In August 1976, the Advisory Committee met formally to discuss materials and information relating to the occupational

safety and health aspects of commercial diving operations. On August 9 and 10, OSHA presented to the Advisory Committee, in addition to the provisions of the ETS and background material, the major concepts contemplated for inclusion in the new proposal. On August 26 and 27, the Committee considered an OSHA draft proposal which was prepared for the Advisory Committee and made available to the public in advance. During the Committee's deliberations, a significant number of oral and written comments were presented by persons representing various sectors of the diving community. In the course of its meeting, the Committee publicly presented its recommendations to OSHA. OSHA has considered all the recommendations of the Advisory Committee, as well as the entire record before the Committee. Many of its recommendations have been incorporated into the proposal. However, based on evaluation of the overall evidence, OSHA was unable to accept certain of the Advisory Committee's recommendations. The reasons for the agency's disposition of the Committee's major recommendations have been included in the substantive explanation of this proposal.

Pursuant to the interagency Memorandum of Understanding dated June 9, 1976 (41 FR 24291, June 15, 1976), the United States Coast Guard intends to publish a notice of proposed rulemaking which will be substantively in agreement with this proposal. The public hearing indicated herein will be held jointly with the United States Coast Guard.

II. Nature of the Diving Industry

A March 1975 analysis, based on data compiled through January 1973, made by NOAA indicated that there were approximately 2,300 commercial divers in the United States at that time. Today, this number has probably increased. Commercial divers perform a variety of underwater tasks and may be engaged in diving in any of the country's coastal waters, the Outer Continental Shelf, throughout the Great Lakes region, or in any of the nation's rivers and inland lakes.

The structure of the commercial diving industry is such that basically 90 percent of all offshore operations are conducted by some 23 contractors who employ over half of the country's commercial divers. In addition, there are approximately 400 small and medium size diving companies, whose work is principally confined to relatively shallow waters in harbors and inland waterways. In much of the diving industry the work is seasonal. All diving contractors, but especially the smaller ones, depend on part-time divers to fill temporary manpower needs.

Prior to about 1960 almost all commercial diving in the United States was located in harbors and inland waterways, and consisted mainly of construction, repair and salvage work. However, with the past decade and a half, in conjunction with the national quest for greater energy and mineral resources, new areas, primarily those located in coastal waters and further offshore areas, have been opened for exploration and development. Recent international political and economic developments have caused this trend to accelerate. This in turn has created a greater demand for the services of divers, who are utilized in each of the three phases of the offshore oil industry: exploration, construction, and production.

According to the U.S. Department of Interior's Bureau of Land Management, there are currently over 2,000 oil and gas producing facilities in the Gulf of Mexico and five off California's Santa Barbara channel. The NOAA study estimated the diver population in the Gulf of Mexico to be 905 full-time and 450 part-time divers. Several states, namely Alaska, California, Texas and Louisiana, have recently expanded their offshore leasing activities. In addition, the Federal government has initiated a program of leasing new sections of the Outer Continental Shelf. Major sales have been made within the past year off the California Coast, the mid-Atlantic Coast, in the Gulf of Alaska, and in the Gulf of Mexico. The leasing schedule calls for six such sales a year through 1978. The Department of Interior anticipates that, as a result of this activity, approximately 400 new platforms and as many as 70 new underwater pipelines will be constructed in the foreseeable future.

While the majority of inland and harbor diving occurs at depths less than 100 FSW, the offshore diver works at depths exceeding 300 FSW, and occasionally to 500–600 FSW. Technology is sufficiently advanced to enable diving to depths approaching and sometimes exceeding 1,000 FSW. Based on the current leasing schedule, working dives to these deeper depths can be anticipated.

III. The Diver's Work Environment

Divers are called upon to use their skills in activities such as construction, repair, salvage, inspection, and rescue operations.

Commercial diving involves exposure to a high degree of risk. The diver's work environment is inherently hostile, containing a multiplicity of hazards. Many divers are subjected to the dangers commonly associated with construction work, such as welding operations and the manipulation of heavy objects. In addition, they must often work in isolation for long periods of time and are exposed to a variety of decompression-related illnesses and injuries.

To perform their tasks, divers must rely completely on external life-support systems while working under severe performance limitations. These limitations include diminished sensory and perceptual capabilities, interference with cognitive processes and psychomotor skills, and reduced physical working capacity. Factors such as environmental, psychological, and/or physiological stress, inadequate or poorly designed tools and inadequate training further impede the diver's efforts. To work successfully, the diver must adapt to his environment, be familiar with his equipment, and learn to select work strategies appropriate to the task.

In diving, several techniques and modes are utilized. These include self-contained (SCUBA), surface-supplied (air or mixed-gas), bell, and saturation diving. Their appropriateness for any particular situation depends on a number of factors, including depth, time, nature of the operation to be performed, and the experience and technical capabilities of the persons involved. Each has its unique operational advantages and poses its special hazards.

SCUBA diving, where the diver carries his own breathing gas supply, is used primarily for inspection and search activities. Diver inwater mobility and ease of operation are its principal assets. The breathing resistance of the diver's equipment, his difficulty in physically orienting himself to the work site, the limited breathing gas supply, and the absence of voice communications with the surface limit the usefulness of SCUBA in commercial activities.

Surface-supplied diving, using either helmet or mask, is more common throughout the diving industry. This method involves supplying the working diver with his breathing mixture, whether air or mixed gas, through a hose from a source located on the working platform. This method of supplying the diver with life support allows some monitoring of his activities because he is tethered to the surface. The major safety limitation of this mode is the duration of inwater exposure. While the diver is working in the water, he is continuously subjected to temperatures, currents and other adverse factors of his working environment. In addition, if decompression is carried out in the water, these factors are intensified, making a protracted inwater stay debilitating.

When a dive is particularly deep or lengthy, the inherent hazards discussed above are exacerbated, and bell diving becomes appropriate. A diving bell is a device which allows the diver to be transported to and from the underwater worksite in an enclosed dry compartment. It may have an open bottom, or it may be closed. With a bell, the diver has a shorter umbilical or life support bundle, is always close to a place of refuge, and can be decompressed in the relative safety of an enclosed environment. In the event of difficulty, the dive can readily be aborted with little jeopardy to the diver.

Mixed-gas diving is carried out with mixtures of oxygen and gases such as helium and/or nitrogen. Mixed gas replaces air as the breathing mixture when the partial pressures of oxygen or nitrogen in the compressed air become toxic or narcotic. Consequently, mixed gas is used during longer and/or deeper dives. Mixed gas is used in conjunction with surface-supplied bell and saturation diving.

Mixed-gas diving may be of short duration, medium duration, or be used in saturation. Short duration mixed-gas dives are used for minor repair, inspection, and other diving support tasks.

Working time is usually 15 to 30 minutes. This type of diving is characterized by relatively short decompression times. Medium duration diving includes dives which generally last up to one hour or more and may involve longer decompression times, depending on depths. Saturation diving is used in situations where the diver will be exposed to hyperbaric pressure for long periods. For diving depths exceeding 400 FSW with working times over two hours, saturation diving is commonly used. In saturation diving, body tissues become saturated with as much inert gas as they can absorb at ambient pressure. The advantage of saturation is that once the body tissues become saturated with inert gas at any given depth, no additional decompression time is needed regardless of the length of time the diver stays at that ambient pressure. However, the saturation mode usually involves very long periods of decompression and isolation for the divers involved. This can be both psychologically and physiologically wearing. The chronic effects, if any, of long-term exposure have yet to be fully evaluated. Saturation diving is always conducted in conjunction with a closed bell or deep diving system.

Whatever the diving technique or mode used, the ability of diving and support personnel to act effectively and safely together is dependent upon their level of competence. Improper actions on the part of the diver or support personnel can quickly lead to dangerous situations; not knowing what to do in an emergency can be fatal. In addition to being qualified to perform their task safely, divers and others who may be exposed to hyperbaric (or high pressure) conditions must be physically fit. It is essential, therefore, that a high level of training, work skill, physical fitness, and supervision be maintained for each diver and diving operation.

In addition to personnel qualifications and medical fitness, a dive crew must follow sound operating procedures to promote the diving operations' safety and efficiency. Although the exact conditions to be met cannot always be determined until the operation begins, advance planning is essential to the proper selection of techniques and equipment which will achieve maximum safety under anticipated conditions. However, no single set of procedures can anticipate all operating situations. Sound judgment, the ability to recognize present or developing hazards, and maximum attention to personnel safety are fundamental to safe diving operations.

Effective planning requires a thorough evaluation of what the diver must do to complete the job. If operations lack appropriate tools or materials for a given task, improvisation of equipment or rigging is inevitable. Improper task evaluation may also require an extension of bottom time, forcing unplanned or lengthened decompression time. Such poor planning increases the danger of the operation to the diver.

Environmental conditions often affect the choice of diving procedure and frequently determine whether diving can be carried out safely. Sea state, sea and air temperatures, weather conditions, underwater visibility and currents, and the nature of the bottom all have significant influence on diving safety and need to be evaluated prior to and throughout any diving operation.

Proper planning for emergencies and development of appropriate contingency plans are essential to the safety of all diving activities. Specific written instructions covering anticipated emergency situations must always be made available to all affected members of the diving team. In an emergency many forms of outside aid may be required. Careful consideration must be given to these factors before any operation is undertaken, so that such aid may be obtained as quickly as possible when needed. Moreover, the remoteness of many dive sites places a premium on effective on-site first aid and medical treatment in emergencies.

For reasons of safety, other precautions must be routinely incorporated into the diving operation. Examples of such precautions are maintaining the diver's body temperature, having sufficient breathing gas reserves in case of failure or depletion of the primary source of supply, and providing a standby diver to aid the working diver promptly when inwater assistance is necessary.

Similarly, whenever diving outside the no-decompression time-depth limits is planned, appropriate decompression tables designed to return the diver to the surface safely must be followed. In the event that decompression sickness does develop, means to recompress the diver to eliminate his symptoms must be available.

The availability of written manuals, dive plans, and predive instructions prior to an operation must be basic to all diving operations. The contribution of written instructions and effective communications to safety is not limited to emergency or contingency situations. Many types of communications are vital to safe diving. Whether used to warn other vessels in the area of the dive operation, to summon emergency aid, or to coordinate operations between the diver and the surface, reliable two-way communication is essential.

The type and quantity of equipment used is also critical to the conduct of a safe operation. All equipment must always be in proper operating condition and thoroughly tested prior to the diving operation. The safety implications of equipment failure or misuse for the diver and possibly the surface crew are so critical that the greatest attention must be given to equipment condition and suitability.

In addition to familiarity with his personal equipment, the diver must also be competent in the use of the tools necessary to perform his tasks. Such familiarity requires training and practice to develop and maintain the required proficiency. This is especially true because many of the work tasks performed by divers, such as burning, welding, and using explosives, are themselves very hazardous.

The quantity and quality of a diver's breathing gas are also fundamental to the diver's safety. The quality of compressed air or mixed gas must always be considered. Oil, carbon monoxide and carbon dioxide can pose significant contamination hazards. Compressors must be well maintained and draw their air from exhaust-free locations. Similarly, all breathing gas hoses must be oxygen cleaned to purge them of contaminants which could otherwise react with oxygen under pressure. Hoses are a diver's lifeline, and, as such, their integrity must be protected to assure safety. All hoses comprising the diver's life support bundle which are exposed to potential damage as a result of falling objects, abuse, or heavy traffic must therefore be protected.

IV. Physiological Hazards

Divers are particularly, and in some cases uniquely, exposed to certain kinds of physiological hazards. On any dive, the diver must adapt to such potentially harmful physical agents as pressure, breathing mixture, water, and possibly to temperature extremes. One pervasive variable is the element of depth. Increased depth means an increase in the pressure exerted on the diver's body, approximately 1 atmosphere (14.7 pounds per square inch) for every 33 feet of depth. While every increase in pressure does not necessarily create a proportionately greater physiological risk, many medical hazards are inherently pressure-related.

In a hyperbaric environment, the increased gas pressure of the breathing mixture forces more gas to be dissolved in the body than occurs at atmospheric pressure. Subsequent ascent to a lesser environmental pressure causes this absorbed gas to come out of solution in the form of bubbles, which can produce decompression sickness and other diving-related disorders either directly or indirectly. This condition can be prevented or at least minimized by controlling the ascent rate of the diver.

The term decompression sickness is applied to adverse symptoms which occur as the result of a reduction in ambient pressure. The symptoms may vary from mild local pain or itching of the skin to neurological effects or collapse with unconsciousness. Decompression sickness usually causes symptoms shortly after a dive or other pressure exposure, or before reaching the surface from deeper dives.

The major categories of decompression sickness are: (1) "Pain-only" or "bends" (limb bends and cutaneous or skin manifestations); (2) audio-vestibular disorders; and (3) central nervous system (CNS) involvement, chokes, shock or unconsciousness. Bends affect joints, and are characterized by a deep, steady pain which is not relieved by movement or changing the position of the limb.

Decompression sickness which causes permanent or residual damage to the

central nervous system or to the audio-vestibular system is particularly serious. Decompression sickness involving the audio-vestibular system may be manifested as partial or total hearing loss, a ringing of the ears, or a sudden severe dizziness and nausea. This type of decompression sickness occurs more often during decompression from very deep dives. Among the symptoms indicating CNS involvement are numbness, weakness, abdominal pain, unconsciousness, shock, visual disturbances, nausea and vomiting, speech difficulty, and dizziness.

Ultrasonic monitoring has shown that some bubbles always exist during decompression, even in the absence of overt symptoms of decompression sickness. These bubbles have been identified as causing damage to the linings of the blood vessels and other changes in the blood itself, and are also the cause of long-term subtle physiological effects on various organs of the body.

As a result of exposure to a hyperbaric environment, divers as a class are also subjected to increased risk of skeletal damage. This damage, generally known as dysbaric osteonecrosis, is the result of gas absorption into and release from tissue which, in varying degrees, cause death of the bone and/or marrow. In its earliest stages, dysbaric osteonecrosis appears as a lesion of a long bone. If a serious lesion is situated near a joint, structural failure which results in pain and limitation of movement may occur. This condition may be followed by the development of degenerative arthritis. While the use of carefully tested decompression tables will not eliminate skeletal damage entirely, the use of such tables may reduce the incidence of dysbaric osteonecrosis.

Other decompression-related medical problems can occur as a result of the reduction of ambient pressure. The most prominent of these is gas embolism, usually caused by over-expansion of the lung, caused by a diver's holding his breath while ascending. Gas forced into the bloodstream continues to expand as the ascent continues; gas bubbles which become too large to pass through the blood vessels cause an obstruction or emoblus which blocks the proper flow of blood. The bubble or embolus of air or gas thus forced into the bloodstream may be carried directly to the brain, arteries, or spinal cord. Such gas may also flow under the skin and collect around the heart or in the chest, causing collapse of a lung. Embolism causes such serious symptoms as weakness, disorientation, visual and hearing disturbances, dizziness, nausea, shock and/or unconsciousness; it is fatal unless recompression is accomplished immediately.

Different problems may arise as a diver descends in the water if the pressure in the natural air passages of the body cannot be equalized due to blockage of air in the passages. This condition is known as barotrauma ("squeeze"). If the pressure imbalance is great enough, ruptured blood vessels or harmful tissue damage can result. This form of barotrauma most commonly affects the middle ear, but may also occur in the external ear, teeth, lungs, intestines, face, or whole body. With the increase in repetitive and deeper exposures, such as those in saturation diving, and the reliance on mixed gas as a breathing mixture, instances of ear squeeze involving auditory and vestibular dysfunction have become more common. Divers cannot safely perform sophisticated underwater operations if their auditory-communication and vestibular-orientation systems are malfunctioning.

A further compression-related physiological hazard is the High Pressure Nervous Syndrome. This is a neurological condition caused by an excessive compression rate while descending to great depths. It is manifested as changes in the brain's electrical activity, causing tremors, fatigue, nausea, and dizziness. Its onset makes effective work at these depths difficult, with concomitant risk to the diver.

In addition to the hazards caused, directly or indirectly, by the increased pressure to which divers are exposed, they are also subjected to a number of hazards associated with their breathing mixtures. The diver's life depends upon the quantity and quality of his breathing mixture. Certain physcial risks are posed to divers by the mere fact that they breathe compressed mixtures, whether air or a mixture of gases (usually oxygen-helium, or oxygen-nitrogen-helium), and they must rely upon special equipment (compressors, gas cylinders, helmets or masks, and hoses). Any deviation from prescribed procedures, particularly in very deep diving, where the margin of error is very narrow, can result in a number of respiratory problems. Because of the particular nature of the underwater environment, any such problem is potentially very serious.

Among the potential dangers relating to breathing mixtures under hyperbaric conditions are oxygen deficiency, oxygen poisoning, nitrogen narcosis, and hydrocarbon contamination. Oxygen deficiency results in insufficient oxygen reaching the cells for normal metabolism. It may occur as hypoxia, or too little oxygen reaching the cells due to loss or inadequacy of the air supply; hypercapnia, or carbon dioxide poisoning resulting from inadequate ventilation; or carbon monoxide poisoning, which may be caused by induction of exhaust fumes into the breathing mixture. Depending on the severity of the condition, symptoms of oxygen deficiency include drowsiness, confusion, lack of fine muscle control, discomfort, rapid breathing, and unconsciousness.

An excess of oxygen as well as its lack can be a problem for the diver. Oxygen must be in all breathing mixtures, but oxygen in excess of that encountered at normal atmospheric conditions may be toxic to the body, depending on its concentration and the length of exposure. Prescribed depth, bottom time, and maximum oxygen partial pressure limits usually prevent the development of oxygen toxicity during the dive. Oxygen toxicity may also be encountered when pure oxygen is administered during decompression or recompression treatment, if the chamber atmosphere is not constantly monitored during decompression. The symptoms of oxygen poisoning most often encountered are muscular twitching, nausea, dizziness, tunnel vision, abnormal hearing, breathing difficulty, anxiety and confusion, unusual fatigue, lack of coordination, and convulsions.

Similarly, high partial pressures of nitrogen in the breathiing mixture produce nitrogen narcosis, which is characterized by slowing of reaction time and mental activity, idea fixation, and general euphoria. There is a wide variance in susceptibility to nitrogen narcosis among individuals, but its symptoms can be felt deeper than 100 feet and increase significantly in air diving deeper than 190 feet. The greatest hazard of nitrogen narcosis is that it may prompt the diver to disregard normal safety precautions.

Another hazard associated with breathing compressed air or mixed gas is the possible presence of contaminants in the breathing mixture which can result in lung damage or pulmonary edema. Contaminants from the engine exhaust or oil from the air compressor can cause serious lung damage if they get into the breathing mixture.

Of course, divers are exposed to the hazards inherently associated with water as a work environment. Drowning, which may be caused by overexertion, panic, or inability to cope with rough water and the effects of adverse water temperature, is one such risk. Prevention of this hazard is best achieved by establishing safe diving practices and by selecting diving personnel carefully.

In addition, the diver is often exposed to the hazards which accompany other physically demanding and stressful occupations. A diver is often called upon to perform difficult work tasks under extreme circumstances. Much of the work involves heavy construction in deep water and the manipulation of large and heavy objects. The normal hazards of such work are compounded by the fact that the diver is in the water, dressed in cumbersome gear, limited in his mobility and visibility, and sometimes restricted to a confined space. The risk of serious trauma is therefore always present, and injuries, such as severe crushing, amputation, head injuries, compound fractures and burns must be anticipated and protected against.

Additionally, any accident or illness, even if otherwise minor, can become a serious medical emergency to a diver who is isolated and in the water under pressure. This period of isolation can be quite lengthy. Accordingly, there is a need for careful advance planning so that personnel may respond to such emergencies in a manner which reduces the likelihood of severe injury and illness.

V. Explanation and Summary of the Proposed Standard

The proposed standard includes requirements for personnel and physical

qualifications, general and specific operation procedures, diving equipment and systems, and recordkeeping and reporting. While similar to the ETS in structure and concept, it differs substantially in several significant respects. An explanation of the substantive provisions of the proposal follows. Reference should also be made to the discussion of the substantive provisions in the preamble to the ETS.

1. *Scope and application* (*§ 1910.401*). The proposal is comprehensive in scope and application, covering all employments within the Act's jurisdiction including general industry, construction and maritime, except for diving operations which involve open-circuit, compressed-air SCUBA diving within the no-decompresion time-depth limits and which are engaged in solely for instructional or educational/scientific purposes. Diving operations must meet all these conditions to be exempt from the standard. Individuals engaged in recreational or sport SCUBA diving for their own personal enjoyment, and not otherwise related to their respective employments, are not within the jurisdiction of the Act, and therefore are outside the scope of this standard.

This exclusion for certain instructional and educational/scientific SCUBA diving is a recognition by OSHA that the working conditions of commercial divers and of SCUBA instructors or educational/scientific divers are not comparable. The latter do not use surface-supplied equipment or mixed gases; do not engage in diving requiring decompression, bells or saturation techniques; do not utilize explosives or burning or welding tools; do not engage in live-boating; and are seldom, if ever, exposed to adverse sea states, temperature extremes, or otherwise less than optimal working conditions. Inasmuch as the substantive provisions of this proposal are addressed to work hazards usually associated with commercial work functions and those involving a high degree of risk or stress, its application to such instructional and educational/scientific SCUBA diving would not be appropriate.

This proposed exclusion rejects the recommendation of OSHA's Advisory Committee on Construction Safety and Health, which urged that the entire diving community be placed under a single standard. The Committee's advice was premised upon the proposition that every OSHA standard should encompass all affected employments and be universally applicable. While not disputing the principle of the Committee's reasoning, OSHA believes that following such a course in this case would neither maximize OSHA's enforcement capability nor appreciably improve the safety and health of the included groups of workers. Because of the widespread interest generated by this issue, OSHA feels that the standard's intended scope should be fully explored during the rulemaking proceeding. Therefore, all potentially affected parties, including those being proposed for exclusion, are urged to address this subject specifically in their comments.

Agencies of the United States government are not considered "employers" pursuant to section 3(5) of the Act (29 U.S.C. 652), and therefore employees of such agencies are not within the jurisdiction of this rulemaking proceeding. Standards affecting such employees are developed in accordance with section 19 of the Act (29 U.S.C. 668), under which it is the responsibility of each agency to establish and maintain an effective and comprehensive occupational safety and health program which is consistent with the standards promulgated by OSHA under section 6 of the Act. In this regard, it should be noted that the agency does not intend that this proposal be made applicable under section 19 of the Act to military diving operations being conducted by Federal agencies. OSHA recognizes that the purposes and circumstances surrounding such operations make the application of the proposed standard inappropriate as a basis for such agency's safety and health program.

For those activities covered by the proposal, the responsibility for compliance with its requirements, as in all OSHA standards, is placed upon the employer. In the ETS, this obligation was generally expressed by requiring the employer to "ensure" that a given requirement be met. Public comments indicated that this was being construed as an imposition of absolute liability upon the employer. This was not OSHA's intention. Therefore, in accordance with the Advisory Committee's recommendation, and to eliminate the possible misinterpretation, the proposed standard has eliminated the use of "ensure" to describe the level of the employer's responsibility for compliance, and has instead substituted "confirm," "provide," "instruct," or other appropriate terms. This change in wording should not be construed as imposing a lesser obligation on the employer than the maximum permitted by the Act.

2. *Definitions* (*§ 1910.402*). In addition to minor modifications to some of the definitions in the ETS, the proposal contains definitions of new terms which appear for the first time. All of these definitions, which conform basically to the general usage in the diving community, serve to clarify the intent of the standard.

3. *Personnel qualifications* (*§ 1910.410*). In addition to stating what an employer must require of divers and other employees with regard to experience, proficiency and medical qualifications, the proposal establishes basic qualifications needed by employees who are to fulfill the functions of diving paramedics, operators of decompression chambers, and designated persons-in-charge of diving operations. In establishing basic criteria for such personnel, the proposal does not intend to create formal job titles or categories, or establish work practices. Depending on circumstances, employees fulfilling these functions may or may not be existing members of the crew engaged in other roles necessitated by the particular diving operation. Without regard to how an employer structures his dive team, it is OSHA's intention to require that a qualified person be designated in charge of each diving operation at all times. This function may be fulfilled either by the employer himself or a qualified employee. This requirement recognizes the need for a person on the site to be responsible for making certain that the operation is carried out in a safe and healthful manner.

4. *Medical requirements* (*§ 1910.411*). The proposal places an obligation on the employer to provide or make available at his cost the services of a licensed physician to perform medical examinations to establish an employee's physical qualifications. Comprehensive medical examinations are necessary so that employers are able to make the required determinations that their employees are physically capable of performing assigned tasks in a safe and healthful manner.

The medical requirements have been expanded to cover all employees who may be subjected to hyperbaric pressure, in addition to divers. Many surface support personnel are qualified divers, but some non-diving employees who are not qualified as divers are occasionally subjected to hyperbaric conditions, as when they are called upon to enter pressure vessels for human occupancy (PVHO's) such as decompression chambers to provide emergency medical treatment. When they do so they, like divers, need to be physically capable of withstanding hyperbaric pressure. These employees must be physically fit and must not have any of the disqualifying medical conditions specifically listed in the medical requirements .

The section on the examining physician's written report makes clear that the employer has an obligation to require the physician to give an opinion as to the employee's fitness to perform his assigned duties. The physician is not asked to make predictions, but rather to offer a medical judgment as to the employee's fitness at the time of the examination. This judgment must be supported by separate opinions as to the state of certain specified and relevant aspects of the employee's physical makeup.

The section on alternative medical examinations as stated in the ETS has been dropped in its entirety. However, the choice of when to administer many of the medical tests (Table I) is left, within certain guidelines, to the discretion of the physician. For instance, the EKG stress and pulmonary function tests are now required only if medically indicated.

The initial examination, which must be conducted within 30 days of the effective date of the standard, can be delayed for as long as a year if an employee can show that he has had a similarly comprehensive examination within the year preceding the effective date of the standard, with satisfactory results. A medical reexamination is required annually. Unless medical reasons dictate otherwise, the annual reexamination is intended to be less comprehensive than the initial examination. A medical reexamination is also required to verify the current fitness of employees to do assigned tasks after sustaining certain classes of injuries and illnesses.

Table I has been modified in accordance with information received from experts in diving medicine since publication of the ETS. The tests listed in Table I were selected to provide the necessary medical information about those aspects of an employee's physical condition which have particular medical relevance for diving and to assure, to the extent possible, that the employee can withstand the particular stresses associated with diving.

Triennial reexamination for bone and joint lesions by X-ray techniques is necessary. Earlier reexamination is necessary in the case of a diver who exhibits evidence of osteonecrosis. The British Medical Research Council (BMRC) Decompression Sickness Registry interpretation of X-rays is required, while its techniques are recommended. This recommendation allows the more advanced radiographic techniques recently developed in this country to be used for bone surveys. It also allows employers to accept the radiographs of employees who have been X-rayed abroad using the British techniques rather than requiring them to undergo additional X-ray exposure. OSHA is aware that the required X-ray examinations may pose a risk with respect to pregnant female divers, and invites additional information and comments on this subject.

Medical testimony presented to the Advisory Committee suggests that standard EKG's only need to be given routinely to persons after the age of 35 who are engaged in a stressful occupation such as diving. The EKG stress test is required only as medically indicated; such examination should only be performed when diagnostic signs indicate that the employee is experiencing abnormal stress when subjected to otherwise physiologically acceptable workloads. In addition, the pulmonary function and the electroencephalogram (EEG) tests are required only when medically indicated.

Audiometry by pure tone audiogram is required initially and annually, and additionally a bone conduction test is required if medically indicated. The ability to hear verbal communication is important to the diver's safety, particularly in light of the proposed standard's requirements for audio-communications.

The uniqueness of the diver's work environment makes diving with certain serious medical conditions incompatible with the goals of safety and health. The list of disqualifying conditions which appeared in the ETS has been restructured and expanded. In particular, drug abuse, history of psychosis, significant malignancies, destruction of one vestibular end organ, recurrent Meniere's disease, and grossly impaired hearing have now been identified as disqualifying conditions. Grossly impaired hearing, as defined in the proposal, is hearing loss sufficient to prevent a diver from responding appropriately to verbal communication from the surface under auditory conditions equivalent to the most difficult to which the diver is likely to be exposed. The list of medical disqualifications has been expanded based on the work done in connection with the NIOSH proposed standard and conforms substantially with the recommendations found in the ADC Manual and the latest ANSI Z-135 drafts. The existence of any of these conditions would create an unacceptably high risk of permanent or serious injury to the employer if exposure is continued and might also jeopardize the well-being of other members of the diving team. OSHA recognizes that requiring an employer to disqualify an employee from work for reasons of safety and health is a sensitive matter, which raises a number of critical issues. As indicated in the recent coke oven standard (41 FR 46742, 46780), this is a policy area to which OSHA intends to devote further study, through an advisory committee, or other means.

While the coke oven standard does not contain a mandatory removal provision if an employee is determined to be at increased risk of material impairment to his or her health from exposure to coke oven emissions, we believe that the particular circumstances present in the diving industry warrant different treatment of this issue at least at the proposal stage. In the first place, the intrinsically hazardous nature of the work environment in diving is such that the exposed employees are uniquely subjected to a continuum of life-threatening situations. Physical incapacity and debilitation, including those of a degenerative and chronic nature, require periodic medical monitoring in light of such contant high-risk exposure. Moreover, diving by an employee with physical incapacity for such activity presents hazards not only to that employee, but to other employees as well. In many cases, divers work in teams, with each member relying heavily on the job performance of the other. The proposed standard itself requires, in many circumstances, the presence of standby divers capable of effectuating rescue or rendering other relief or assistance. In these situations the incapacity of one diver would present a serious hazard to his fellow employee diver. Therefore, OSHA specifically invites comment on any issue raised by this provision, including pertinent medical information relating to the listed disqualifying conditions, the required medical examinations, and possible alternatives to employee withdrawal.

The proposal also includes a provision for review of any determination made by the employer pursuant to this section which would result in withdrawal of an employee from further exposure or would place permanent limitations on the employee's activities. The review procedure would be initiated upon request of an affected employee and would require the employer to reconsider determination based on a report from a second examining physician, selected by the employee, and if the two determinations differed, to make his final determination based upon the written report from a third examining physician whose selection had been agreed upon by the first two physicians. OSHA invites comment on this or other procedures for review of determinations of employee qualifications based upon medical examinations made pursuant to this section.

The employee should select examining, consulting, and on-call physicians referred to in the proposal who possess broad knowledge of diving physiology, hyperbaric medicine, and treatment of diving-related injuries and illnesses. Training courses in hyperbaric medicine are available. One such curriculum, approved by the Undersea Medical Society, has been given to licensed physicians at the University of Southern California. Other opportunities for continuing education in diving medicine are being planned.

5. *Safe practices manual* (*§ 1910.420*). The requirements for developing and maintaining a safe practices manual remain essentially the same as those which appeared in the ETS. Basically, they require that an employer describe in writing the methods and procedures necessary for performing the various types of diving operations in a safe and healthful manner.

6. *General operations procedures* (*§ 1910.421*). A safe practices manual must be developed and include, among other things, the applicable general and specific operations procedures contained in the standard. A review of some of the major requirements for general operations procedures follows.

The first-aid requirement of the ETS has been modified to include a simple oral (oropharyngeal) airway suitable for mouth-to-mouth resuscitation in the first-aid supplies. The Advisory Committee agreed to the addition of an oral airway, but recommended that the requirement for a resuscitator be deleted on the grounds that there is a danger of overpressurization which could be fatal to a diver with an air embolism. Recognition of this danger prompted OSHA to limit the requirement to manually operated rather than automatic resuscitators. Manual resuscitators are designed to preclude overpressurization, and the widely recognized life-saving value of such equipment has convinced OSHA of its great importance to diving first-aid. A further requirement that the mask and connecting tubes of the resuscitator be translucent has been added. This reduces the potential for damage to the diver's lungs by allowing the operator to see whether or not the air passages are clear of any congestion such as vomitus.

At the recommendation of the Advisory Committee, the first-aid training provision has been strengthened to require that at least one employee at each worksite have a current certificate in advanced first-aid. In addition, the proposal requires a diving paramedic at the work site for any diving operation which is one hour or more travel time from a medical treatment facility, or for an operation involving mixed-gas diving with bottom depths deeper than 400 FSW where decompression tables are not in compliance with the standard's performance criteria (during the phase-in period of one year from the effective date of the standard). Paramedics are required for those diving operations where de-

compression sickness is most likely to occur, or in situations where adequate medical care is particularly unavailable. The proposal's diving paramedic requirement can be satisfied by an employee trained as an Emergency Medical Technician/Diving (EMT/D), a military medic with additional experience in diving medicine, or a diver who has completed the American Red Cross advanced first-aid course and has had additional training in cardiopulmonary resuscitation. Currently, several Undersea Medical Society-approved courses for EMT/D training are available.

The ETS required that those engaged in activities which may pose a hazard to diving operations be notified of the planned diving operation. This requirement has been retained in the proposed permanent standard. Examples of such activities are underwater blasting, movement of surface vessels, and movement of material directly over the work site.

A new category of underwater hazard has been added to the proposal. The employer must take all necessary steps to have mechanical apparatus capable of creating strong water currents, high intensity sonar, and active cathodic protection inactivated, and have the controls for such devices tagged prior to the diving operation.

The temporary impairment of condition section which appeared in the ETS requires consultation with the affected employee before any action is taken. It has been expanded to include pregnancy as an example of a condition which may warrant temporary abstention from diving. Medical opinion indicates that vascular changes associated with pregnancy may increase the susceptibility of the pregnant diver to decompression sickness. OSHA invites comments on this subject.

The pre-dive instruction requirement of the ETS has been modified to include the requirement that a written diving plan be made available to affected employees at the work site whenever the planned operation deviates substantially from procedures in the safe practices manual if the necessary details are known sufficiently in advance to make such documentation practicable. OSHA believes that this requirement is important because effective advance planning and employer-employee communication is vital to a safe diving operation.

The pressure vessel for human occupancy (PVHO) requirement specifies that the decompression chamber be on site for dives outside the no-decompression time-depth limits. In addition, it must be dual-lock and multiplace to allow supplies and personnel into and out of the chamber. The Advisory Committee recommended that a chamber be on site for all dives deeper than 66 FSW. The ETS had required an on-site decompression chamber for any diving operation involving 30 minutes or more decompression time. However, the proposal requires that a decompression chamber be immediately available for all dives outside the no-decompression time-depth limits because the probability of decompression sickness increases with time and depth.

The PVHO requirement reflects the recommendation of the Advisory Committee that decompression chambers have a minimum capability of 6 ATA (165 FSW). Most decompression chambers in existence are constructed with this capability, which is adequate for the treatment of most types of decompression sickness. For bell and deep diving systems, either a decompression chamber with a pressure capability equivalent to the depth of the dive must be available, or the bell or deep diving system itself must be capable of carrying out any applicable mixed-gas or saturation decompression treatment procedure. This will allow recompression to depths deeper than 165 FSW if the type of decompression sickness incurred requires such recompression and treatment.

Regardless of the type of diving operation, employers must maintain up-to-date information as to the location of a nearby decompression chamber when one is not otherwise required on site. Knowledge of the location of other medical facilities as well as a list of sources of emergency aid are also required by the proposal. In the event of a medical emergency, this information would enable a disabled diver or other member of the support crew to be transported promptly to an appropriate treatment facility.

Post-dive precautions governing the diver's activities following dives outside the no-decompression time-depth limits are included in the proposal. These did not appear in the ETS. They require the employer to take all reasonable steps to have his employees remain on site and awake for at least one hour, and within two hours' travel time of the chamber for an additional five hours, following such dives. Moreover, diving operations conducted at altitudes significantly above sea level are required to use decompression procedures which take the reduced surface pressure into account. Employers are also required to instruct employees engaged as divers against flying within 12 hours after a dive outside the no-decompression time-depth limits or within 24 hours after a saturation dive, except in an emergency. Each of these requirements addresses situations known to increase the probability of occurrence or recurrence of decompression sickness.

Because overheating may be a danger in certain climates, the requirement in the ETS that the standby diver be suited at all times has been eliminated, as recommended by the Advisory Committee. However, the standby diver must still be available to reach the diver as quickly as possible. This allows the standby diver to be suited to the degree that will enable him to meet this requirement and avoid the possibility of overheating.

In consonance with U.S. Coast Guard policy, the warning display provision has been simplified to require only the display of the international code flag "A" near all dive work sites. This provision brings the standard into conformity with recent Congressional ratification of the Convention on International Regulations for Preventing Collisions at Sea 1972, Rule 27. The international treaty will become effective on July 15, 1977. Other warning displays such as the American dive flag may still be flown, but not in lieu of the international code flag "A."

The general requirement for positioning or mooring vessels is intended to provide a safe working platform. The actual method by which vessels are positioned or moored is dependent upon the design of the vessel and operating procedures and is therefore not addressed in the proposal.

The proposal also includes a requirement for the recording of accurate time-depth profiles for all dives. This is essential to determine which decompression schedule is to be followed, and may also affect the choice of a recompression regimen.

In addition, the requirement for the employer's record of dives now states that an automatic recording of the time-pressure profile which can be monitored at the surface is required for all air dives deeper than 190 FSW and for all mixed-gas dives. The Advisory Committee recommended that this requirement be limited to mixed-gas diving in the saturation and bell-diving modes. However, the proposal does not follow the Committee's recommendation because the need for automatic recorders derives from the increased hazards asssociated with the use of mixed gas and of air diving below 190 FSW, and does not relate specifically to the use of a bell or the technique of saturation. The maintenance of accurate time-depth profiles is essential to determine a diver's decompression obligation. An automatic record provides a continuous check on decompression tables and virtually eliminates timing errors, making the decompression assessment required in the proposal more accurate and easier to perform. Recording the data simultaneously with the dives adds considerably to diving safety by eliminating human error. While not eliminating the need for crew attention, it nonetheless frees surface support personnel for more important jobs in an emergency. Automatic recording helps to avert accidents by enabling surface personnel to locate an injured diver and quickly dispatch a standby diver. Knowing that a reliable record is being made, crew members will make a greater effort to follow procedures precisely and will be discouraged for departing from planned and established dive procedures. Automatic recording also makes it easier to determine the immediate cause of mishaps and miscalculations, and to take proper corrective action when these occur. The automatic recording requirement is designed to establish an accurate, contemporaneous, and documented record of critical data for deep air or mixed-gas dives which are inherently hazardous.

7. *Diver's log* (*§ 1910.422*). A requirement that each diver be required by his employer to keep a diver's log was not included in the ETS, but was presented to the Advisory Committee for considera-

tion. The Advisory Committee recommended that the diver's log be included in the standard as a recommended practice rather than a requirement. The Committee's opinion was basically that the provision would be difficult and unfair to enforce against the employer. While the proposal would require maintenance of a diver's log, no documentation of a diver's work history prior to the effective date of the standard is required. The diver's log will contribute significantly to future diving safety by providing uniform and reliable documentation of the diver's training, education, diving experience, medical status, and diving-related injuries and accidents. This information will help the employer determine which divers are qualified to perform different work assignments safely, and whether the diver is susceptible to decompression sickness in certain situations.

8. *Specific operations procedures (§ 1910.423)*. In addition to the general operations procedures, the proposed standard requires certain procedures which are specific to different types of diving. These procedures concern self-contained diving, surface-supplied diving, air diving, mixed-gas diving, bell diving, and live-boating.

For self-contained (SCUBA) diving, the requirement of an appropriate weight belt and a cylinder harness has been added to the proposal. A personal flotation device is required to be worn for SCUBA diving except for diving in the saturation mode or in enclosed spaces. Compressed air cylinders for SCUBA diving must be inspected annually both internally and externally for rust or pits, as well as hydrostatically tested every 5 years. In addition, the weight belt and a body harness have been added as requirements for surface-supplied diving.

The bottom time limit for air diving between 190 and 220 FSW has been extended from 10 to 30 minutes, as recommended by the Advisory Committee. This is based on testimony before the Advisory Committee that diving has been conducted safely at these depths for up to 30 minutes. On the basis of this information, the 10-minute limit stated in the ETS has been modified to allow for the performance of underwater tasks which have been conducted safety at this time/depth limit. Moreover, medical testimony presented to the Advisory Committee indicated that the effects of nitrogen narcosis, the greatest potential hazard of air diving at these depths, are not cumulative, and the hazard does not therefore increase significantly if bottom times are extended from 10 to 30 minutes.

A provision has been added to the mixed-gas diving requirement to indicate that air may be used as an emergency reserve in the event of failure of the reserve mixed-gas breathing supply.

The depth limits for bell diving remain the same as those set forth in the ETS. An open or closed bell shall be provided and used for all dives of 220 FSW or deeper and for all dives which require more than 120 minutes of decompression time, but a closed bell must be provided and used for all dives of 300 FSW or deeper. However, this requirement has been refined to reflect the Advisory Committee's recommendation that an explicit exception be made for diving inside confined structures where bells cannot fit. The principal purpose of the bell requirement is to provide a sheltered haven or working environment for divers whose work requires exposure to significant depths or lengthy decompressions. Use of a bell also facilitates medical treatment and, by allowing several divers to share work assignments, reduces fatigue and promotes safety. The advantages of a closed bell are that it eliminates inwater decompression time and provides maximum protection from the underwater environment.

This proposal addresses deep diving bells and systems specifically with regard to regulation of pressure and depth, reserve breathing gas supply, minimum number of divers and standby divers, and the need for an evacuation plan. Design and engineering requirements have generally not been included at this time. The technological response to the demand for new systems capable of operating at increased depths has produced many design variations of deep diving systems. These include mobile units for inwater personnel transport and submarine propulsion units for remote operations. Prime considerations for these systems are life-support systems and reserves, structural integrity, and emergency evacuation recue capability. Interested parties are requested to comment on the safety and health aspects of this area of technology for possible inclusion in the final standard.

The requirements in the proposal concerning live-boating have been made more stringent than those appearing in the ETS. The proposal requires that a propeller protective device or equally safe alternative means be used to prevent hose entanglement, and that a reserve breathing gas supply be carried by the diver. In addition, the proposal prohibits live-boating at night, in rough seas, and at depths below 220 FSW or involving decompression times greater than 120 minutes. These add to the risks associated with this intrinsically hazardous technique. The 220 FSW and 120 minute decompression time limits are consistent with the proposal's depth and time requirements for bell diving.

While the proposal applies to commerical diving and related operations generally, there are no specific requirements relating to closed-circuit and semi-closed-circuit breathing systems or to one-atmosphere units. OSHA recognizes that such systems may pose hazards which are not addressed by the proposed standard. Therefore, OSHA invites interested parties to submit comments with respect to the usage and associated hazards of such systems in commercial diving.

9. *Maximum allowable oxygen and nitrogen limits (§ 1910.424)*. To reduce the likelihood of oxygen or nitrogen poisoning or lung irritation, the proposal sets maximum allowable limits for oxygen and nitrogen. Table II in the proposal sets a limit on th maximum oxygen partial pressures allowed for various exposure times. The limits of Table II are based upon those specified and used by the U.S. Navy. Adoption of this table is in accordance with the Advisory Committee's recommendations. These oxygen partial pressures have been used widely since the 1940's and 1950's. However, there is increasing evidence both from the laboratory and the field that these levels of oxygen for working divers may result in greater uptake of helium or other inert gases at greater depths, and thus may increase the likelihood of decompression sickness. Tables using higher partial pressures have had satisfactory results in deep diving operations. OSHA invites testimony and evidence on this subject.

The maximum limit for the partial pressure of nitrogen has been set to conform to the nitrogen partial pressure of air at 220 FSW, which is proposed as the maximum depth for air diving. Adherence to this limit will minimize the risk of sereve nitrogen narcosis.

10. *Decompression table assessment (§ 1910.425)*. The section on decompression table assessment is derived from the approach initially developed by NIOSH, and refined by OSHA based on information received from experts in the field. In establishing this program, OSHA has taken the current state of the art into consideration and recognized the fact that decompression table development is an empirical science. At the same time, it has attempted to avoid building an acceptable rate of decompression sickness into the standard, while encouraging improvement in present tables as well as the development of new and safer decompression tables.

In addition to requiring the use of decompression tables based on tested and accepted physiological criteria, it includes a comprehensive phasing program which provides for continual assessment by the employer of the performance of his decompression tables. The assessment procedure requires documentation of the number of decompression sickness incidents incurred in the field. Documentation must be based on categories specified in the proposal (air diving, mixed gas diving to 400 FSW, saturation diving, and mixed gas diving deeper than 400 FSW). To enable an employer to determine when decompression tables require corrective action, a chart which has been designated as Performance Criteria A has been included. When the number of incidents in any assessment category exceeds the maximum indicated by Performance Criteria A for a specified number of dives, the affected schedules or table must be investigated, modified, or its use discontinued. If a table or schedule has failed to meet the performance criteria for three out of five assessment periods, the proposal requires the involved schedules or table to be returned to the laboratory for modification and retesting until 12 consecutive man-dives under simulated working conditions have been achieved without decompression

sickness. A minimum of six subjects is required for such testing to take individual susceptibility to decompression sickness into account. This laboratory procedure must also be followed when new decompression tables are being introduced prior to initial field use.

Because mixed-gas tables for bottom depths deeper than 400 FSW cannot at present meet the stringent criteria established in Performance Criteria A, the standard proposes a phase-in which requires tables for this type of dive to meet the criteria of Performance Criteria A within one year from the effective date of the standard. Such a phasing program allows time for the necessary research to develop satisfactory tables for mixed-gas diving in this depth range. In the interim, to afford maximum protection, a diving paramedic must be on site when such tables which do not yet meet the standard's performance criteria are used. In addition, as with all dive categories, the number and type of decompression sickness incidents incurred with such tables must be recorded. However, if any residual audio-vestibular or neurological incident is incurred during the phase-in period, the proposal requires the employer to take appropriate corrective action, including discontinuing the use of the involved table or schedule.

Three years from the effective date of the standard, Performance Criteria A will be superseded by Performance Criteria B, which establishes more stringent performance criteria against which all decompression tables regardless of mode will have to be assessed. Diving physiologists familiar with the development and testing of such tables have indicated to OSHA that this two-step phasing program is within the limits of technological feasibility.

Alternatives to the proposed two-step phasing program will be considered by OSHA during the rulemaking proceedings, and are appropriate subjects for public comment and evidence.

11. *Electrical hand tools, welding and burning, and explosives* (*§§ 1910.426.-428*). Additional requirements have been included in the proposal to increase the safety of certain potentially hazardous work operations that a diver is often called upon to perform. To reduce potential shock hazards and accidental operation of tools, all hand-held electrical tools, including those inside bells and saturation habitats, must be de-energized at the surface when being placed into or retrieved from the water. All hand-held power tools, whether electric, hydraulic, or pneumatic, must be provided with a constant pressure switch or control to turn off instantly when released by the diver. Welding machine frames must be securely grounded. Proper protection and insulation are required, both for the electrical circuit and the diver's personal equipment. Closed compartments, structures, or pipelines subject to the heat of welding or burning must be purged with inert gas, flooded, or vented at the outset of a welding or burning operation, except during hot tapping operations, where these procedures are not appropriate. Requirements for special precautions have been added with respect to the use of explosives in diving operations. Employers engaged in the transport, storage, or use of explosives must comply with the requirements of §§ 1910.109 and 1926.912, as appropriate. In addition, magazine boxes must be used to store and transport single component explosives; blasting caps must not be stored with explosives; and divers must be out of the water before any electrical circuits are tested and before explosives are detonated.

12. *Fire, emergency and evacuation procedures* (*§ 1910.429*). The fire, emergency and evacuation procedures section has been enlarged to include provisions for developing fire fighting and emergency plans to cover the actual dive operations and their immediate work areas. Specifically, this modification is necessary because the general fire-fighting and evacuation plans for the ship, vessel or other work site do not usually include the equipment or personnel utilized in diving operations.

13. *Diving equipment and systems* (*§§ 1910.430.438*). The sections concerning diving equipment and systems are substantially the same as those which appeared in the ETS. The standard establishes certain basic hardware requirements which are deemed essential to diver safety and health. It also provides for the periodic testing of certain equipment and the recording of the results of such testing in an equipment log. These requirements are designed to assure that the equipment is maintained in proper working order throughout the diving operation.

Specifically, the equipment and systems covered are helmets and masks; dry suits; gas supply hoses; air compressors and systems for respirable air; pressure vessels for human occupancy (PVHO's); air receivers; depth gauges; and compressed gas equipment (except SCUBA cylinders).

A requirement has been included in the proposal concerning any modification made to the design and/or operation of any equipment, device, or system that changes its operational characteristics with respect to the breathing gas flow. Any such modification is to be noted in the equipment log. This emphasizes the need to exercise caution in making modifications which might adversely affect the quantity or quality of the breathing mixture supplied to the diver.

Another significant change from the ETS, which would bring the standard into conformity with industry practice, is the reduction of the testing requirement for gas supply hoses and fittings to 1.5 times their maximum working pressure. The maximum allowable working pressure is defined as no less than the maximum depth of the dive (converted to pounds per square inch (psi)) plus 100 psi.

The air purity requirement has also been changed. The permissible carbon monoxide level has been reduced to 15 parts per million by volume, and the carbon dioxide level to 500 parts per million by volume. In addition, a hydrocarbon level of no greater than 5 milligrams per cubic meter has been established. This high degree of air purity is required because it is crucial that a diver's breathing mixture be free of contamination. For the same reason, a provision has been added which requires the compressor output to be analyzed once every 1,000 operating hours or once every six months, whichever occurs first, to verify that the air purity requirements are being met. A record of these readings must be kept in the equipment log.

14. *Recording and reporting* (*§§ 1910.-440–441*). The recording and reporting sections are similar to those contained in the ETS with the exception of certain provisions dealing with time requirements for record retention. The documentation of diving operations in safe practices manuals, diving plans, manual and automatic dive records, decompression table assessments and verifications, PVHO oxygen concentration monitoring records, and equipment logs, is required to be retained by the employer for a period of three years. However, the medical records must be retained for a period of five years, because it is important to be able to trace an employee's medical history over a longer period. There is medical evidence that dysbaric osteonecrosis may develop as long as five years or more after the causal incident. The Advisory Committee recommended that no reporting requirements beyond those specified in 29 CFR Part 1904 be included in the diving proposal. However, the unique nature of the hazards to which a diver is exposed makes it essential that severe cases of decompression sickness having residual effects as well as those diving-related accidents and injuries sufficiently serious to require 5 days' medical care or 72 hours in a hospital be recorded and reported in addition to those required by 29 CFR Part 1904.

VI. Economic Impact

OSHA has determined that pursuant to section 6(b) of the Act the economic feasibility and potential inflationary impact of the proposed commercial diving standard should be considered in this rulemaking proceeding. Accordingly, notice is being given that OSHA has prepared an economic and inflation impact analysis for the proposed standard. The economic and inflationary impacts were evaluated pursuant to section 6(b) of the Act and in accordance with the Secretary of Labor's Order 15–75 (40 FR 54484, November 24, 1975) and the Office of Management and Budget Circular A–107 (January 28, 1975), issued pursuant to Executive Order 11821 (39 FR 41501, November 27, 1974). Information, data, and comments concerning economic feasibility and inflationary impact are invited for presentation at the hearing. With respect to the potential inflationary impact attention is directed to the following issues set out in the Secretary's Order:

(1) Cost impact on consumers, businesses, markets, or Federal, State or local government;

(2) Effect on productivity of wage earners, businesses or government;

(3) Effect on competition;
(4) Effect on supplies of important materials, products or services;
(5) Effect on employment; and
(6) Effect on energy supply or demand.

In addition, comments are also invited on the benefits to be derived from the proposed standard.

The inflationary impact analysis required by Executive Order 11821 has been prepared pursuant to section 5(b)(8) of Secretary's Order 15–75, prior to the promulgation of the final standard. Such analysis is available for inspection and copying at the Technical Data Center, New Department of Labor Building, Room N–3620, Third Street and Constitution Avenue, NW., Washington, D.C. 20210 (Tel.: 202–523–8076).

VII. Environmental Impact Assessment

As indicated when the ETS was published (41 FR 24284), it has been determined pursuant to 29 CFR 1999.3 that the proposed standard for commercial diving will not significantly affect the quality of the human environment, nor is the environmental impact of this proposal likely to be highly controversial. Therefore, the Assistant Secretary has determined that an environmental impact statement is not required.

VIII. Public Participation

Interested persons are invited to submit written data, views, and arguments with respect to all issues raised by this proposal. Such comments must be postmarked on or before December 6. All written comments must be submitted in quadruplicate to the Docket Officer, Docket No. at the Technical Data Center, New Department of Labor Building, Room N3620, Third Street and Constitution Avenue, NW., Washington, D.C. 20210 (Tel: 202–523–8076). Written submissions must clearly identify the portions of the proposal or the issues addressed and the position taken with respect to each.

An opportunity to submit oral testimony concerning all the issues raised in the proposal, including economic and potential inflationary impact, is being provided at an informal public hearing, under section 6(b)(3) of the Act scheduled to begin at 9:30 a.m. on December 13, 1976, in New Orleans, Louisiana, at Braniff Place Hotel, Terrace Suites 3, 4, 5, 1500 Canal St., New Orleans 70130.

Persons desiring to appear at the hearing must submit a notice of intention to appear postmarked on or before December 6 to the OSHA Committee Management Office, Docket No. Room N–3633, U.S. Department of Labor, Third Street and Constitution Avenue, NW., Washington, D.C. 20210 (Telephone: 202–523–8024). The notices of intention to appear, which will be available for inspection and copying in the Office of Committee Management, must contain the following information:

(1) The name and address of the person who will appear;
(2) The capacity in which the person will appear;
(3) The approximate amount of time required for the presentation;
(4) The specific provisions of other issues raised by the proposal that will be addressed;
(5) A detailed statement of the position that will be taken; and
(6) A detailed statement of the evidence which will be presented at the hearing.

All submissions received, including data, views, arguments and notices of intent to appear, will be made a part of the record of this proceeding. The amount of time requested for each presentation will be reviewed in light of the contents of the notice of intention to appear. In those cases where the information contained in the notice of intention to appear does not warrant the amount of time requested, the participant will be allocated a more appropriate amount of time and be notified of this fact.

The hearing will commence at 9:30 a.m. on December 16, 1976 with the resolution of any other procedural matters relating to the proceeding. The hearing will be conducted and the decisions made in accordance with 29 CFR Part 1911.

The oral proceedings will be reported verbatim and a transcript will be made available for inspection and copying by interested persons. Prepared statements and documents that are intended to be submitted for the record at the hearing shall be submitted in quadruplicate at least 48 hours before the beginning of the hearing.

An Administrative Law Judge will be designated to preside at the hearing and shall have all the powers necessary or appropriate to conduct a fair and full informal hearing, including the powers:

(1) To regulate the course of the proceedings;
(2) To dispose of procedural requests, objections, and comparable matters;
(3) To confine the presentations to matters pertinent to the proposal and related issues;
(4) To regulate the conduct of those present at the hearing by appropriate means;
(5) In his discretion, to question and permit questioning of any witness; and
(6) In his discretion, to keep the record open for a reasonable, stated time to receive written information and additional data, views, and arguments from any person who has participated in the oral proceedings.

Following the close of the hearing, the presiding Administrative Law Judge shall certify the record thereof to the Assistant Secretary of Labor. The proposal will be reviewed in light of all oral and written submissions received as part of the record in the entire rulemaking proceeding and appropriate action will be taken.

Accordingly, pursuant to the authority cited above, it is proposed to amend Chapter XVII of Title 29, Code of Federal Regulations, to add a new permanent occupational safety and health standards for commercial diving operations, as set forth below.

It is hereby certified that the economic and inflationary impacts of this proposed regulation has been carefully evaluated in accordance with OMB Circular A–107.

Signed at Washington, D.C. this ____ day of November 1976.

MORTON CORN,
Assistant Secretary of Labor.

1. In Part 1910 of 29 CFR, Subpart T would be revised to read as follows:

PART 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Subpart T—Commercial Diving Operations

GENERAL

Sec.
1910.401 Scope and application.
1910.402 Definitions.

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1910.411 Medical requirements.

OPERATIONS PROCEDURES

1910.420 Safe practices manual.
1910.421 General operations procedures.
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1910.427 Welding and burning.
1910.428 Explosives.
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DIVING EQUIPMENT AND SYSTEMS

1910.430 Equipment.
1910.431 Helmets and masks.
1910.432 Dry suits (variable volume).
1910.433 Breathing gas hoses.
1910.434 Air compressors and systems for respirable air.
1910.435 Pressure vessels for human occupancy (PVHO).
1910.436 Depth gauges.
1910.437 Compressed gas equipment.
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RECORDKEEPING REQUIREMENTS

1910.440 Recording and reporting.
1910.441 Availability of records.

AUTHORITY: Sec. 6, 8, 84 Stat. 1593, 1596, 1599 (29 U.S.C. 655, 657); Secretary of Labor's Order 8–76 (41 FR 25059); 29 CFR Part 1911; sec. 41, 44 Stat. 1444 (33 U.S.C. 941); sec. 107, 83 Stat. 96 (40 U.S.C. 333).

Appendix A—Recommended British Medical Research Council Decompression Sickness Registry Techniques, Skeletal Radiological Investigation For Divers

Subpart T—Commercial Diving Operations

GENERAL

§ 1910.401 Scope and application.

(a) This subpart applies to every place of employment within the inland and territorial waters of the United States, or within any State, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, The Trust Territory of The Pacific Islands, Wake Island, Johnston Island, the Canal Zone, or within the Outer Continental Shelf lands as defined in the Outer Continental Shelf Lands Act (67 Stat. 462, 43 U.S.C. 1331), where diving and related operations are

carried out, except that this subpart will not apply to working conditions with respect to which other Federal agencies exercise statutory authority to prescribe or enforce standards or regulations affecting occupational safety and health.

(b) This subpart applies to diving and related operations conducted in connection with all types of work and employments, including general industry, construction, ship repairing, shipbuilding, shipbreaking, and longshoring; except this subpart shall not apply to any diving operation:

(1) Performed solely for instructional or educational/scientific purposes; and

(2) Utilizing open-circuit, compressed-air SCUBA; and

(3) Conducted within the time-depth limits of no-decompression diving.

(c) This subpart requires employers engaged in diving operations to:

(1) Require that all employees engaged in diving operations are qualified to perform their work assignments in a safe and healthful manner as provided in §§ 1910.410 and 1910.411;

(2) Develop, maintain and comply with a safe practices manual as provided in § 1910.420;

(3) Follow safe and healthful operations procedures as provided in §§ 1910.421 to 1910.429;

(4) Provide appropriate diving equipment and systems as required in §§ 1910.430 to 1910.438; and

(5) Record and report job-related fatalities and serious illnesses, injuries and accidents, and make all required records available to the Assistant Secretary for Occupational Safety and Health in accordance with §§ 1910.440 and 1910.441.

§ 1910.402 Definitions.

As used in this subpart, the listed terms are defined as follows:

"ATA": Atmosphere absolute, a unit of pressure equivalent to 760 millimeters of mercury (mmHg).

"Ascent time": The time interval between leaving the deepest point of the dive and returning to the surface (1 ATA).

"Bell diving": a diving mode which uses a diving bell.

"Blowout": uncontrolled loss of gas or liquid from a subsea wellhead.

"Bottom time": The time interval between leaving the surface (1 ATA) and the beginning of ascent from the deepest point of the dive.

"Breathing mixture": air or a mixture of gases breathed by a diver which contains a physiologically appropriate proportion of oxygen.

"Bursting pressure": the pressure exerted by a medium such as a breathing mixture at which the containment vessel would fail structurally.

"Decompression": the reduction of environmental or ambient pressure to atmospheric pressure.

"Decompression chamber": a PVHO (Pressure Vessel for Human Occupancy) used to decompress divers by reducing pressure under controlled conditions; also used to treat decompression sickness by recompression.

"Decompression schedule": a time-depth profile with a specified bottom time and depth, whose application is calculated to reduce the pressure on a diver safely.

"Decompression sickness": A condition with a variety of symptoms which may result from the formation of gas or gas bubbles in the blood or other tissues of divers during or subsequent to ascent or other pressure reduction. Residual audio-vestibular or neurological symptoms involve permanent damage to the hearing or balance system, or to the peripheral or central nervous system, respectively. Serious symptoms involve the sensory or neurological systems significantly, and include numbness, paralysis, visual and hearing disturbances, chokes, shock, and unconsciousness. Pain-only symptoms are limited to localized joint and muscle pain, minor muscle weakness and skin itching, tingling, or redness. Pain-only symptoms which recur during or after recompression therapy are classified as serious symptoms.

"Decompression table": a set of decompression schedules computed on common parameters.

"Diver": an employee engaged in work using underwater apparatus which supplies compressed breathing gas at ambient pressure from a self-contained or remote source.

"Diving bell": an open-bottom or closed device which allows the diver to be transported to and from the underwater work site in an enclosed compartment partially dry (open-bottom bell) or totally dry (closed bell).

"Dry suit (variable volume)": a diving suit capable of being inflated for buoyancy or insulation which keeps the diver's body essentially dry.

"Exhaust line guard": A device to prevent injury from contact with the exhaust line opening inside a PVHO when gas is being vented from the PVHO.

"Exhaust valve": a valve controlling the venting of gas from a PVHO, diver's helmet, suit, or buoyancy-changing equipment.

"FSW": a foot of seawater; a unit of pressure generally defined as $\frac{1}{33}$ of a standard atmosphere, which represents the pressure exerted by a foot of seawater having a specific gravity of 1.027, equal to approximately .445 pounds per square inch.

"Heavy gear diving": diving which uses standard deep sea dress, including helmet and brass breastplate, suit of rubberized canvas, and heavy weighted shoes.

"Hard piping": rigid permanent or semi-permanent piping, as distinguished from temporary, flexible hoses.

"Helmet (open-circuit and/or surface-supplied)": breathing and protective equipment which encloses the diver's head.

"Hot tapping": the use of hot or cold methods to penetrate a structure such as a pipeline or other structure which is in operation and contains a combustible substance.

"Hyperbaric conditions": pressure conditions in excess of surface pressure (1 ATA).

"Life-support hose bundle (umbilical)": a composite hose/cable or separate cables extending from the surface to the diver or PVHO which supplies breathing gas, power, heat, or communication, as necessary.

"Life-support equipment": equipment designed to provide the diver with an appropriate respirable atmosphere and other protection as required.

"Live-boating": the practice of supporting a diver from a vessel which is underway.

"Mask (open-circuit and/or surface-supplied)": breathing and protective equipment which covers a diver's face.

"Mixed-gas diving": a diving technique in which the diver is supplied with a gas mixture other than air.

"No-decompression diving": diving which involves depths and times shallow and short enough so that controlled ascent can be made without stops or stages, e.g., dives within the time-depth limits of the no-decompression table in the U.S. Navy Diving Manual.

"Non-return valve": a one-way check valve installed at the hose-helmet attachment point or elsewhere in the system, which is designed to prevent suction or loss of the diver's breathing mixture should the hose be severed or the gas supply be interrupted.

"Oxygen cleaning": special cleaning precautions taken to prevent oxygen under pressure from igniting flammables on contact.

"Oxygen compatibility": the ability of a substance to come into contact with high-pressure oxygen without ignition.

"Partial pressure": that portion of the total gas pressure exerted by a particular constituent of the breathing mixture.

"Pneumofathometer": a depth measuring device indicating depth in FSW, consisting of an open-ended hose fixed to the diver, with the other end connected to an air supply and pressure gauge at the surface.

"Pressure": force per unit of area. In diving, pressure denotes an exposure greater than surface pressure (1 ATA).

"PVHO": Pressure Vessel for Human Occupancy. A pressure vessel designed to contain a human being.

"Receiver": a pressure vessel (other than a SCUBA cylinder) for the storage of gases.

"Recompression": an increase in pressure which is calculated to eliminate the symptoms of decompression sickness when applied to a diver in a PVHO as therapy.

"Saturation diving": a diving mode in which the diver's body is saturated with inert gas so that additional time spent at pressure does not result in additional uptake of gas nor require an increase in decompression time.

"Saturation habitat": a fixed or movable system of single or multiple PVHO's in which a diver lives under saturation and from which he may make working excursions.

"SCUBA": self-contained underwater breathing apparatus.

"Self-contained diving": a diving mode which allows the diver to carry his own breathing gas supply and be inde-

pendent of the surface with regard to breathing gas.

"Standby diver": a diver available to go to the aid of another diver in the water or assist in the retrieval of a PVHO.

"Surface-supplied diving": a diving mode in which the diver receives breathing gas from the surface.

"Treatment table": a time profile of pressure and breathing gas whose application is calculated to eliminate the symptoms of decompression sickness.

"Work site": a vessel or surface structure from which dives are supported and/or the underwater location where work is performed.

"Working pressure": the normal operating pressure exerted by a medium such as a breathing mixture. The ratio of bursting to working pressure is the factor of safety.

PERSONNEL REQUIREMENTS

§ 1910.410 Personnel qualifications.

(a) *General.* Each employer engaged in diving operations shall require that all employees engaged as divers or in surface support operations meet the medical requirements and possess the necessary experience and proficiency to perform their work assignments in a safe and healthful manner in accordance with the provisions of this subpart.

(b) *Required experience and proficiency.* Employers shall require that employees assigned to specific diving activities shall possess the following:

(1) Knowledge and skills gained through training or experience in the following:

(i) Diving procedures and techniques,

(ii) Emergency procedures,

(iii) Physiology as it relates to diving, and

(iv) Diving equipment;

(2) Familiarity with procedures and proficiency in the use of tools, equipment and devices relevant to the assigned tasks;

(3) For employees engaged as divers ditions, physical qualifications for such or otherwise exposed to hyperbaric conactivities, determined in accordance with the requirements of § 1910.411;

(4) For employees engaged as diving paramedics, who have been trained as Emergency Medical Technicians/Diving (EMT/D), Navy Hospitalmen or equivalent, knowledge of diving medicine and treatment to the degree that will enable such persons to handle medical and diving emergencies under the direction of an on-call physician; and

(5) For employees who operate decompression chambers, knowledge of chamber operations, the use of treatment tables and post-treatment procedures.

(c) *Employee training.* Where an employee does not possess the skills and training in diving procedures or techniques or in the safe use of tools, equipment, or devices, the employer shall assign another employee who possesses the necessary skills and training, except that the employer may assign limited tasks to employees undergoing training provided such tasks are performed under the direction of experienced and qualified employees.

(d) *Designated person-in-charge.* (1) The employer or a qualified employee designated by the employer shall be in charge of each diving operation.

(2) The responsibilities of such designated person shall include job coordination and planning, pre-dive instructions, fire, emergency, and evacuation procedures, tool and equipment inspections, supervision of decompression treatment, maintenance of the employer's record of dives, and otherwise confirming that work practices, procedures, and equipment conform to the requirements of this subpart.

(3) The employer shall require that any person designated in accordance with paragraph (d)(1) of this section has had previous qualifying experience as a commercial or military diver.

§ 1910.411 Medical requirements.

(a) *General.* Every employer shall provide or make available at no cost to employees engaged as divers or otherwise subjected to hyperbaric conditions, the services of a licensed physician to perform the following medical examinations:

(1) An initial medical examination;

(2) Annual reexaminations; and

(3) A reexamination after a diving-related injury or illness.

(b) *Information provided to the examining physician.* The employer shall provide the following information to the examining physician:

(1) A copy of this subpart;

(2) A summary of the duties to which the employee may be assigned; and

(3) Information from previous reports of physicians concerning the affected employee, upon request of the examining physician.

(c) *Physical examination.* (1) The employer shall provide employees engaged as divers or otherwise subjected to hyperbaric conditions with an initial medical examination, except as described in paragraph (c)(2) of this section, and annual medical reexaminations, which shall include the following:

(i) Work history;

(ii) The tests required in Table I, as appropriate;

(iii) Any tests deemed necessary to establish the presence or absence of any of the disqualifying conditions listed in paragraph (f) of this section; and

(iv) Any additional tests the physician deems necessary to prepare the written report required by paragraph (e) of this section.

(2) Within 30 days from the effective date of this subpart, the employer shall provide employees engaged as divers or subjected to hyperbaric conditions with a medical examination, except if an employee can show to the satisfaction of the employer after consultation with the examining physician, that within one year prior to the effective date of this subpart he has had a comprehensive medical examination comparable to the initial examination required by this section, and that the results of this examination did not indicate the presence of significant abnormalities affecting the organs, systems, or general health of the employee, as listed in paragraph (e)(1)(ii) of this section, or any of the conditions in paragraph (f) of this section. At the termination of one year from the date of such comparable medical examination, the employer shall provide such employee with an annual medical reexamination as required in paragraphs (a) and (c)(1) of this section.

TABLE I.—*Medical tests for diving*

Test	Initial	Annual Re-examination	Comments
History and physical	X	X	Include predisposition to unconsciousness, vomiting, cardiac arrest, impairment of oxygen transport, serious blood loss, or anything which, in the opinion of the examining physician, will interfere with effective underwater work.
Chest X-ray	X	X	PA (projection: 14 by 17 in, minimum).
Bone and joint X-ray survey	(1)	(1)	For divers engaged in dives outside the no-decompression time-depth limits, required initially and every 3 years, and as medically indicated. (British Medical Research Council Decompression Sickness Registry interpretation required; British Medical Research Council Decompression Sickness Registry techniques recommended. For techniques, see appendix A).
EKG: Standard (12 L)	X	(1)	Required initially to establish baseline, annually after age 35, and as medically indicated.
EKG: Stress			Required only as medically indicated.
Pulmonary function			Do.
Audiogram	X	X	Threshold audiogram by pure tone audiometry; bone conduction audiogram, as medically indicated.
EEG			Required only as medically indicated.
Visual acuity	X		Required initially and as medically indicated.
Color blindness	X		Required initially.
Hematocrit, hemoglobin, white blood count.	X	X	
Routine urinalysis	X	X	

[1] See comments.

(d) *Reexamination after injury or illness.* (1) The employer shall provide any employee engaged as a diver or otherwise exposed to hyperbaric conditions with a medical examination following a diving-related injury or illness which requires hospitalization of 72 hours or more, or a diving-related injury or illness requiring treatment by an attending physician for a period of at least 5 days, or known decompression sickness with audio-vestibular or central nervous system dysfunction.

(2) The employer shall not permit the employee to return to work as a diver or otherwise be subjected to hyperbaric conditions until he is physically fit to do so, based on the physician's report.

(3) The examining physician shall determine the scope of the examination in light of the nature of the injury or illness.

(e) *Physician's writen report.* (1) With respect to the initial examination, annual reexaminations and reexamination after a diving-related injury or illness, the employer shall obtain a written report from the examining physician containing the following information:

(i) A statement indicating the results of the medical examinations and tests given in accordance with this section;

(ii) The physician's opinion as to the fitness of the employee to perform his duties based on the employee's medical history and any medical deficiencies revealed by the tests required in Table I, particularly with respect to the following:

(A) Stress to the pulmonary, muscular, cardiac, and skeletal systems,

(B) Interference with effective external communication of the gas-containing organs of the body,

(C) Condition of the central and peripheral nervous system, and

(D) Any other factor which indicates material impairment of the employee's health;

(iii) The physician's opinion based on the employee's medical history and any medical deficiencies revealed by the tests required in Table I, or any other tests necessary, as to whether any of the conditions listed in paragraph (f) of this section exist;

(iv) Any recommended limitations upon the employee's activities as a diver or exposure to hyperbaric conditions; and

(v) A statement that the employee has been informed by the examining physician of the results of the examination and any medical conditions which require further examination or treatment.

(2) The employer shall instruct the physician not to reveal in the written report specific findings or diagnoses unrelated to occupational exposure to the underwater environment.

(3) The employer shall provide a copy of the physician's written report to the affected employee.

(f) *Disqualifying conditions.* The employer shall disqualify from diving or exposure to hyperbaric conditions any employee who is found by the examining physician to have any of the following:

(1) History of seizure disorder other than early childhood febrile convulsions;

(2) Cystic or cavitary disease of the lungs, significant obstructive or restrictive lung disease, or recurrent pneumothorax;

(3) Chronic inability to equalize sinus and middle ear pressure;

(4) Significant central or peripheral nervous system disease;

(5) Significant cardiac abnormalities;

(6) Chronic alcoholism, drug abuse, or history of psychosis;

(7) Significant hemoglobinopathies;

(8) Significant malignancies;

(9) Destruction of one vestibular end organ, recurrent Meniere's disease, or grossly impaired hearing; or

(10) Significant osteonecrosis.

(g) *Withdrawal of employee.* (1) The employer shall determine on the basis of the physician's written report whether an employee's health would be materially impaired by continued diving or exposure to hyperbaric conditions or whether there are necessary limitations on the employee's activities.

(2) If indicated by such determination, the employer shall withdraw the employee from such exposure or shall appropriately limit the employee's activity.

(3) Upon notification of withdrawal from diving or permanent limitation of activity, any affected employee may request that a second medical opinion be obtained from a physician chosen by such employee.

(4) If the employer's determination based on the medical opinion of the second physician differs from the first, a third medical opinion shall be obtained from a physician jointly agreed upon by the first two physicians.

(5) The written report of the third physician shall be the basis for the employer's final determination.

(h) *Medical recordkeeping.* (1) The employer shall establish and maintain a accurate medical record for each employee subject to the medical requirements of this section. The record shall include:

(i) Physicians' written reports; and

(ii) A copy of the information provided to the physician as required by paragraph (b) of this section.

(2) The employer shall maintain this record for at least 5 years following the employee's last hyperbaric exposure with such employer.

(3) Upon request by the employee or former employee, the employer shall transfer a copy of the employee's medical record to a physician designated by the employee or former employee.

Operations Procedures

§ 1910.420 Safe practices manual.

(a) *General.* Each employer engaged in diving operations shall develop and maintain a safe practices manual, and shall follow the procedures set out in such manual for all diving operations.

(b) *Content.* The employer shall inclde in the safe practices manual the safety and health requirements for each tvpe of diving operation engaged in by the employer, to include the following:

(1) The assignment of qualified employees to enable the operation to be performed in a safe and healthful manner in accordance with the requirements of §§ 1910.410 and 1910.411;

(2) Operations procedures, including fire emergency and evacuation procedures, consistent with applicable provisions contained in §§ 1910.421 to 1910.429: and

(3) The use of diving equipment and systems which shall comply with the requirements of §§ 1910.430 to 1910.438.

(c) *Availability.* The employer shall make the safe practices manual readily available:

(1) At the work site;

(2) To all employees involved in diving operations; and

(3) Upon request, to the Assistant Secretary or his designee.

§ 1910.421 General operations procedures.

(a) *General.* The employer shall conduct all diving operations in compliance procedures contained in this section.

(b) *Emergency aid.* (1) The employer shall develop and maintain a list of the available sources of emergency aid, equipment, and professional assistance with their call signs or phone numbers and instructions for establishing contact with them.

(2) The employer shall make the list available at the work site, at the employer's principal place of business and at the field operations offices.

(3) The employer shall include in the list information necessary for the requisition of, or access to, the following types of emergency aid appropriate for the type of diving operations engaged in:

(i) Decompression chamber (when not otherwise required by paragraph (i) of this section);

(ii) Hospital or medical treatment facility;

(iii) Air transportation;

(iv) On-call physician; and

(v) U.S. Coast Guard Rescue Coordination Centers.

(4) The employer shall confirm that two-way communications necessary to the requisition of, or access to, the emergency aid, equipment, and professional assistance shall be available or accessible to the work site.

(c) *First aid.* (1) The employer shall provide and keep readily available at the work site first-aid supplies approved by a consulting physician and appropriate to the employer's diving operations, including a copy of the American Red Cross Advanced First-Aid Manual or equivalent. Such supplies shall include an oral airway (oropharyngeal, approximately 4" in length) suitable for mouth-to-mouth resuscitation.

(2) The employer shall provide a manual resuscitator (bag tvpe) consisting of manually controlled oxygen flasks, transparent mask and connecting tubing, and spare flasks for immediate use at the work site.

(3) In the absence of a physician or a diving paramedic, the employer shall provide at the worksite an employee who has a valid certificate in advanced first-aid training from the American Red Cross or equivalent training and who has training in the use of a manual resuscitator.

(4) In addition to the requirement of paragraph (c) (2) of § 1910.425, the employer shall provide a diving paramedic for any diving operation which is one hour or more travel time from a medical treatment facility.

(d) *Hazards to diving operations.* (1) The employer shall give notice of the planned diving operations, including the

daily start and finish times, to those in the vicinity whose activities may interfere with or pose a hazard to the diving operations, such as underwater demolition operations, movement of surface vessels, or lifting of material directly over the diving operations.

(2) Whenever hazardous activities in the vicinity of the diving operations or conditions such as weather or sea state may interfere with the ability of an employee to perform safety underwater or impair his health, the employer, after consultation with the affected employee, shall not allow such employee to dive for the duration of such hazardous activity or adverse condition. In no case shall the employer require an employee to dive against the employee's will.

(e) *Temporary impairment or condition.* The employer shall not permit employees to dive or be otherwise exposed to hyperbaric conditions for the duration of any known temporary impairment or condition such as a cold, alcoholic intoxication or its aftereffects, influence of drugs, pregnancy, respiratory or middle ear disease, skin or external ear infection, or excessive fatigue or emotional distress, if such impairment or condition is likely to impair the health or interfere materially with the employee's ability to perform a specific diving task or be exposed to hyperbaric conditions safely. The employer shall consult with the affected employee before making such determination. In no case shall the employer require an employee to dive or be exposed to hyperbaric conditions against the employee's will.

(f) *Inspection of tools, equipment and operational systems.* (1) The employer shall confirm that all tools, equipment, and operational systems used in diving operations are in proper working order, appropriate for the tasks, and in compliance with §§ 1910.430 to 1910.438.

(2) Tools, equipment, and operational systems used in diving operations shall be inspected at the commencement of each day's diving operations, and monitored throughout the operations by the designated person-in-charge of the diving operations.

(3) The employer shall confirm that each employee engaged as a diver in the diving operation has inspected his personal diving equipment prior to each day's diving.

(g) *Diving plan.* (1) The employer shall develop a written diving plan for each diving operation which varies from any provisions described in the safe practices manual. Where such information is not known sufficiently in advance to make written documentation practicable, such information shall be conveyed verbally.

(2) The employer shall include in the diving plan references to the provisions of the safe practices manual that apply to the specific diving operation and shall include any additional instructions which are necessary to carry out the diving operations safely.

(3) The employer shall make the diving plan available to affected employees at the work site.

(4) Prior to commencing and engaging in each diving operation the employer shall inform each employee involved of the information contained in the safe practices manual and the diving plan pertaining to the diving operation.

(h) *Means for entering and leaving the water.* The employer shall provide safe means for entering or leaving the water from the diving platform. Additionally, the means of entering and leaving the water shall be adequate to facilitate rescue of personnel.

(i) *Pressure vessel for human occupancy (PVHO).*

(1) For any dive outside the no-decompression time-depth limits, the employer shall provide a dual-lock, multiplace decompression chamber having a minimum capability of 6 ATA (equivalent to 165 FSW) ready for use at the work site, with a qualified chamber operator. The decompression chamber shall accommodate the diver(s) and a person rendering treatment.

(2) For bell or deep diving system operations, the employer shall provide a deck decompression chamber capable of recompression to the depth of the dive, or such bell or deep diving system shall be capable of carrying out any applicable mixed-gas or saturation decompression treatment procedure.

(3) The employer shall provide appropriate decompression and treatment tables at the work site.

(j) *Post-dive precautions.* After the completion of any dive outside the no-decompression time-depth limits, the employer shall:

(1) Take necessary steps to have employees engaged as divers remain awake and in the vicinity of the decompression chamber for at least one hour;

(2) Instruct such divers to remain within two hours' travel time of the decompression chamber for an additional five hours; and

(3) Instruct such divers to avoid flying, except in an emergency, within:

(i) 12 hours after decompression from a dive outside the no-decompression time-depth limits, or

(ii) 24 hours after decompression from a saturation dive.

(k) *Diving at altitude.* For any diving operation conducted at an elevation significantly above sea level, the employer shall utilize decompression procedures which take the reduced surface pressure into account.

(l) *Thermal exposure.* Additional precautions shall be taken by the employer to protect the diver from adverse thermal exposure while engaged in diving.

(m) *Standby diver.* The employer shall provide a standby diver to be available and located as specified to perform the following functions:

(1) At the surface, to aid a working diver engaged in any dive outside the no-decompression time-depth limits, except that when two divers are in the water working together and can reach each other within 3 minutes a standby diver is not required;

(2) Near the surface, to tend a bell during retrieval;

(3) At the surface, to aid a working diver engaged in a live-boating operation; and

(4) At the point of entry to tend a diver entering a tunnel, wreck, pipe, or similarly enclosed or confining underwater structure (other than a saturation habitat).

(n) *Underwater hazardous conditions.* (1) Additional precautions shall be taken by the employer and reviewed with the employee to protect such employee diving in the vicinity of underwater suction hazards such as sluices and major inflow/outflow pipes.

(2) Whenever possible, employers shall not expose employees engaged as divers to the hazards of strong water currents created by mechanical apparatus, high intensity sonar, or effects of active cathodic protection, and shall confirm that such devices are inactivated and their controls tagged prior to the commencement of the diving operation.

(o) *Warning display.* The employer shall display a rigid replica of the international code flag "A" not less than 1 meter in height near the work site so that it has all-round visibility.

(p) *Reserve breathing gas supply.* The employer shall provide and make available to each diver engaged in a diving operation a reserve breathing gas supply physiologically appropriate for the depth of the dive. Such supply shall be sufficient for life support until the diver can safely return to a place of refuge or the surface.

(q) *Communications.* The employer shall provide an operating 2-way audio communication system between the diver and the tender, except as permitted by paragraph (b) (1) of § 1910.423.

(r) *Employer's record of dives.* (1) The employer shall establish and maintain a record of each diver's diving exposure. This record shall contain the following:

(i) Name and address of the employer;

(ii) Location and date of diving operation;

(iii) Names of divers, tenders, and person-in-charge;

(iv) Depth of dive;

(v) Bottom time;

(vi) Water temperature and thermal protection used;

(vii) Environmental conditions (sea state, underwater visibility, and underwater currents);

(viii) Decompression tables used;

(ix) Breathing mixture used and composition;

(x) Type of work performed;

(xi) Type of diving equipment worn;

(xii) Any unusual conditions, including decompression sickness incidents; and

(xiii) Repetitive dive designation or time of last pressure exposure.

(2) For a diving operation with uniform exposures involving more than one diver, a single record applicable to all involved divers is sufficient. Where the exposure of any diver varies in any respect, the employer shall keep a separate record of these variations.

(3) The employer shall record accurate time-pressure profiles for all dives.

The time-pressure profile shall be automatically recorded and shall be capable of being monitored at the surface for all air dives deeper than 190 FSW and for all mixed-gas dives.

(s) *Positioning.* Employers shall confirm that vessels from which diving operations are conducted are fixed or dynamically positioned to afford a safe working platform.

§ 1910.422 Diver's log.

(a) *Format and entries.* (1) The employer shall require that each employee engaged as a diver establish and maintain a personal diver's log.

(2) The diver's log shall contain:

(i) A record of diving employment from the effective date of this subpart, including job titles, dates, and employers' names and addresses. Each employment entry shall be attested to by the employer's signature;

(ii) A complete record of civilian and military educational and training courses, including course titles and names and addresses of institutions;

(iii) A record of dates of all medical examinations required by this subpart, and names and addresses of examining physicians; and

(iv) Information pertinent to each diving exposure, to include the following:

(A) Location, date, and time of diving operation,

(B) Dive depth,

(C) Bottom time,

(D) Diving equipment used,

(E) Breathing mixture used,

(F) Repetitive dive designation,

(G) Occurrence of decompression sickness, and

(H) Signature of the designated person-in-charge on site.

§ 1910.423 Specific operations procedures.

(a) *General.* In addition to the general operations procedures required by § 1910.421, the employer shall comply as appropriate with the specific operations procedures contained in this section.

(b) *Self-contained diving.* The employer shall comply with the following procedures for self-contained diving operations.

(1) The employer need not provide the communications required by paragraph (q) of § 1910.421 for an employee who is accompanied by another diver (buddy) or who can communicate with the tender on the surface through a safety line using pull signals.

(2) The planned time of such a diving operation, including decompression time, shall not exceed the air supply duration of the cylinders exclusive of the reserve supply. The reserve gas supply as required in § 1910.421(p) shall not be included in the planned time of the dive.

(3) The cylinder pressure shall be determined immediately before each dive.

(4) A weight belt with a simple, quick release shall be worn which is appropriate for the suit and depth of the dive.

(5) A cylinder harness with a simple, quick release shall be worn to secure the breathing mixture cylinders to the diver.

(6) The weight belt and cylinder harness shall be independently attached to permit release of either one without interference by the other.

(7) A personal flotation device shall be worn except for diving in enclosed spaces or in the saturation mode.

(8) Compressed breathing gas cylinders shall be:

(i) Annually inspected internally and externally for corrosion and pitting;

(ii) Subjected to a hydrostatic test of 5/3 times the maximum allowable working pressure of the cylinders at least every 5 years, and additionally, prior to use when visibly damaged or significantly pitted or corroded. The date of the hydrostatic test shall be stamped on the tested cylinders;

(iii) Removed from service if they do not meet the requirements of the hydrostatic test. Results of inspections and tests shall be recorded in the equipment log in accordance with § 1910.438; and

(iv) Filled from a compressed gas system equipped with a relief valve that controls the maximum filling pressure.

(c) *Surface-supplied diving.* The employer shall comply with the following procedures for surface-supplied diving operations.

(1) The depth of each dive shall be determined prior to the start of operations.

(2) Except when an integral part of the gear, a weight belt with a simple, quick release appropriate for the suit and depth of the dive shall be worn.

(3) Except for heavy gear diving, a separate safety harness with a positive buckling device shall be worn. The harness shall distribute the load of the diver's body, and shall prevent any strain from being placed on the diver's mask or helmet when the umbilical attached to the lift ring on the harness is pulled.

(d) *Air diving.* The employer shall limit air dives between 190–220 FSW to a bottom time of 30 minutes or less.

(e) *Mixed-gas diving.* The employer shall comply with the following procedures for mixed-gas diving operations.

(1) The breathing mixture supplied to the diver shall be composed of a mixture of gases that is appropriate for the depth and duration of the dive.

(2) Mixed gas shall be used as the breathing mixture for dives deeper than 220 FSW.

(3) In the event of failure of the reserve mixed-gas breathing supply, air may be used as an emergency breathing mixture.

(f) *Bell diving.* The employer shall comply with the following procedures for bell diving operations.

(1) A minimum of 2 divers shall be used for dives using a closed diving bell.

(2) Open or closed bells shall be provided and used for dives of 220 FSW and deeper, other than structurally enclosed dives, and for dives which require more than 120 minutes of decompression time, except that closed bells shall be provided and used for dives of 300 FSW and deeper.

(g) *Live-boating.* The employer shall comply with the following procedures for live-boating operations.

(1) When live-boating, a protective device shall be installed on the propeller or other equally effective means shall be taken to prevent the hose from becoming entangled in the propeller.

(2) A reserve breathing gas supply shall be carried by each diver engaged in live-boating. The supply shall be sufficient for life support until the diver can be safely returned to the surface.

(3) Live-boating shall not be conducted at night or in rough seas.

(4) Live-boating shall be limited to dives with depths of 220 FSW or less, or decompression times of 120 minutes or less.

§ 1910.424 Maximum allowable oxygen and nitrogen limits.

(a) *Partial pressure of oxygen.* The employer shall confirm that the partial pressure of oxygen in the breathing mixture supplied to divers during the underwater working interval does not exceed the levels in Table II for the exposure times indicated.

TABLE II

Maximum oxygen partial pressure, ATA:	*Maximum exposure time*
1.6	30 minutes
1.5	40 minutes
1.4	50 minutes
1.3	1 hour
1.2	1 hour 20 minutes
1.1	2 hours
1.0	12 hours
0.5	over 12 hours

(b) *Long-duration oxygen limits.* The employer shall confirm that the maximum continuous oxygen level in a saturation habitat does not exceed a partial pressure of 0.5 ATA.

(c) *Partial pressure of nitrogen.* The employer shall confirm that the partial pressure of nitrogen in the air supplied to divers working underwater does not exceed 6.1 ATA (equivalent to 220 FSW).

§ 1910.425 Decompression table assessment.

(a) *General.* The employer shall utilize decompression tables based on tested and accepted physiological criteria, and shall assess such tables in accordance with the assessment program specified in this section.

(b) *Categories of dive records.* The employer shall separate and analyze dive records according to the following categories:

(1) Air dives deeper than 66 FSW or outside the no-decompression time-depth limits;

(2) Mixed-gas dives with bottom depths in the range from 0–400 FSW, by table;

(3) Saturation dives; and

(4) Mixed-gas dives with bottom depths deeper than 400 FSW, by table.

(c) *Phasing of effective dates.* Commencing with the effective date of this subpart, the employer shall assess rec-

ords of air dives deeper than 66 FSW or outside the no-decompression time-depth limits, mixed-gas dives with bottom depths in the range from 0–400 FSW, and saturation dives in accordance with Performance Criteria A; and additionally, the employer shall evaluate records of mixed-gas dives with bottom depths deeper than 400 FSW as required in paragraphs (d) and(e) (1), (2) and (3) of this section.

(2) Commencing one year from the effective date of this subpart, the employer shall assess records of mixed-gas dives with bottom depths deeper than 400 FSW in accordance with Performance Criteria A. For a period of one year from the effective date of this subpart, the employer shall only conduct mixed-gas dives with bottom depths deeper than 400 FSW:

(i) With a diving paramedic on site (unless Performance Criteria A is met); and

(ii) Using a schedule or table which has incurred no incident of the type of decompression sickness specified in Column 3 of Performance Criteria A or B.

Performance criteria A

Number of decompression sickness incidents	Number of dives		
	1	2	3
	Total, all types of decompression sickness	Serious	Residual audiovestibular or neurological
1	29–30	93–123	Any incident in any number of dives requires corrective action in accordance with para. (e)(5).
2	31–38	124–152	
3	39–46	153–180	
4	47–54	181–207	
5	55–62	208–233	
6	63–70	234–259	
7	71–78	260–285	
8	79–86	286–310	
9	87–93	311–335	
10	94–101	336–361	

NOTE.—The minimum number of dives required for assessment of col. 1 is 22, and for col. 2, 93. Col. 1 includes all types of decompression sickness: pain-only, serious, and residual.

(3) Commencing three years from the effective date of this subpart, the employer shall assess records of air dives deeper than 66 FSW or outside the no-decompression time-depth limits, mixed-gas dives with bottom depths shallower than 400 FSW, mixed-gas dives with bottom depths deeper than 400 FSW, and saturation dives in accordance with Performance Criteria B.

Performance criteria B

Number of decompression sickness incidents	Number of dives		
	1	2	3
	Total, all types of decompression sickness	Serious	Residual audiovestibular or neurological
1	44–61	165–349	Any incident in any number of dives requires corrective action in accordance with par. (e)(5)
2	62–78	350–307	
3	79–95	308–363	
4	96–111	364–417	
5	112–127	418–470	
6	128–143	471–522	
7	144–158	523–574	
8	159–174	575–624	
9	175–189	625–674	
10	190–205	675–724	

NOTE.—The minimum number of dives required for assessment of col. 1 is 44, and fo. col. 2, 188. Col. 1 includes all types of decompression sickness: pain-only, serious, and residual.

(d) *Assessment period.* The employer shall assess records of dives each assessment period, and shall complete such assessment within 45 days from the close of the period being assessed. An assessment period shall be one calendar month or, if longer, the time necessary to attain the minimum number of dives specified in Performance Criteria A or B, as appropriate, except that the assessment period shall terminate as soon as one residual audio-vestibular or neurological incident is incurred or as soon as two Column 1 or two Column 2 incidents are incurred in less than the minimum number of dives specified in Performance Criteria A or B, as appropriate.

(e) *Assessment procedure.* (1) The employer shall total the number of dives and the number of incidents of decompression sickness by types (Column 1, all types; Column 2, serious; Column 3, residual audio-vestibular or neurological) indicated in Performance Criteria A or B, as appropriate, for each category of dive specified in paragraph (b) of this section.

(2) The employer shall compare his total incident/total dive figures for each type of decompression sickness for each category of dive with the appropriate column of Performance Criteria A or B, as appropriate.

(3) If the employer's total for any type of decompression sickness for any category of dive exceeds the maximum indicated for the specified number of dives in Performance Criteria A or B, as appropriate, the employer shall investigate the circumstances surrounding the dive(s) in question, and shall prepare a written analysis evaluating these circumstances.

(4) If the employer's total for any type of decompression sickness for air dives deeper that 66 FSW or outside the no-decompression time-depth limits, mixed-gas dives with bottom depths in the range from 0–400 FSW, or saturation dives exceeds the maximum indicated for the specified number of dives in Performance Criteria A or B, as appropriate, for two out of three assessment periods, the employer shall:

(i) Modify the procedures, schedule(s) or table(s) in a manner calculated to effect improvement; and

(ii) Document and explain the changes made in such procedures, schedule(s) or table(s).

(5) If the employer's total for any type of decompression sickness for air dives deeper than 66 FSW or outside the no-decompression time-depth limits, mixed-gas dives with bottom depths in the range from 0–400 FSW, or saturation dives exceeds the maximum indicated for the specified number of dives in Performance Criteria A or B, as appropriate, for three out of five assessment periods, the employer shall:

(i) Discontinue use of the schedule(s) or table(s) involved, or return such schedule(s) or table(s) to a laboratory for modification and testing;

(ii) Have such modified schedule(s) or table(s) tested:

(A) In a manner which permits the results of such testing to be applied to the entire table with validity,

(B) Using at least six subjects performing physical work, and

(C) Until 12 consecutive man-dives without decompression sickness have been attained on each schedule or table tested; and

(iii) Document the testing required above.

(6) Commencing one year from the effective date of this subpart, if the employer's total for any type of decompression sickness for mixed-gas dives with bottom depths deeper than 400 FSW exceeds the maximum indicated for the specified number of dives in Performance Criteria A or B, as appropriate, for:

(i) Two out of three assessment periods, the employer shall follow the procedures specified in paragraph (e) (4) of this section; or

(ii) Three out of five assessment periods, the employer shall follow the procedures specified in paragraph (e) (5) of this section.

(f) *New table assessment.* The employer shall have written verification that each new table has been tested in the laboratory in accordance with the requirements of paragraph (e) (5) of this section before such table is used in the field.

§ 1910.426 Hand-held power tools.

(a) *De-energizing tools.* The employer shall de-energize all hand-held electrical tools, including hand-held electrical equipment inside bells and habitats, at the surface when being placed into or retrieved from the water.

(b) *Switches and controls.* The employer shall confirm that hand-held power tools (electric, hydraulic and pneumatic) have a constant pressure switch or control.

§ 1910.427 Welding and burning.

(a) *Grounding.* The employer shall confirm that welding machine frames are securely grounded.

(b) *Insulation.* The employer shall confirm that welding cables, electrode holders, and connections are properly insulated.

(c) *Disconnect switch.* The employer shall confirm that the welding electrical circuit has a positive disconnect switch. The switch shall remain open except during actual underwater welding or burning.

(d) *Protective apparel.* The employer shall confirm that insulated gloves are worn by divers engaged in welding or burning.

(e) *Inert gas purging.* The employer shall confirm that closed compartments, structures or pipelines which are subjected to the heat of welding or burning are flooded, vented or purged with inert gas prior to welding or burning, except during hot tapping operations.

§ 1910.428 Explosives.

(a) *General.* Employers shall transport, store and use explosives in compliance with § 1910.109 and § 1926.912 of

this chapter, as appropriate, and with the requirements of this section.

(b) *Transport and storage.* The employer shall confirm that single component explosives are transported and stored in magazine boxes. Blasting caps shall not be stored with explosives.

(c) *Circuit tests.* The employer shall confirm that electrical continuity of explosive circuits are not tested with divers in the water.

(d) *Area clearance.* The employer shall confirm that divers are out of the water before explosives are detonated.

§ 1910.429 Fire, emergency and evacuation procedures.

(a) *Fire.* The employer shall develop a fire fighting plan specifically covering diving operations and their immediate work areas in addition to any general fire fighting plan for the vessel, platform, facility, or other work site from which diving operations take place. Fire fighting equipment appropriate to implement the plan shall be available and ready for use at the work site during diving operations.

(b) *Emergency.* The employer shall develop an emergency plan which shall include procedures for the following contingencies or emergencies:

(1) Loss of voice communications;

(2) Interruption of the surface gas supply;

(3) Parting of the diver's life support hose bundle (umbilical);

(4) Diver entanglement or entrapment;

(5) Oxygen poisoning;

(6) Nitrogen narcosis;

(7) Decompression sickness;

(8) Uncontrolled buoyant ascent (blowup);

(9) Physical injury; or

(10) Acute illness.

(c) *Evacuation and rescue.* The employer shall develop evacuation plans for surface-supplied, saturation, and bell diving operations including the rescue or retrieval of manned PVHO's in emergencies such as:

(1) Storms, fires, or blowouts requiring evacuation of the work site (work platform); or

(2) Loss of power which significantly affects the ability to maintain life support systems.

(d) *Instructions.* The employer shall instruct members of the diving team in fire fighting, emergency, and evacuation procedures and assignments prior to commencing diving operations.

DIVING EQUIPMENT AND SYSTEMS

§ 1910.430 Equipment.

(a) *General.* Employers engaged in diving operations shall instruct employees in the use of tools, equipment and systems so as to comply with the requirements of this subpart.

(d) *Modification.* The employer shall confirm that any modification made to the design and/or operation of any equipment, device, or system that changes its operational characteristics with respect to breathing gas flow is noted in the equipment log in accordance with § 1910.438.

§ 1910.431 Helmets and masks.

(a) *General.* (1) The employer shall confirm that open-circuit helmets and masks (except oral-nasal) are capable of ventilating at least 4.5 cubic feet per minute (cfm) of gas when supplied at the pressure recommended by the manufacturer of the equipment.

(2) A 2-way, audio-communication system shall be incorporated into helmets and masks used for diving operations except as specified in paragraph (b) of § 1910.423.

(b) *Surface-supplied helmets and masks.* The employer shall confirm that surface-supplied helmets and masks:

(1) Are equipped with non-return valves;

(2) Are made of corrosion-resistant materials if used in salt water; and

§ 1910.432 Dry suits (variable volume).

The employer shall confirm that dry suits (variable volume) or similar buoyancy-changing equipment which do not connect directly to the helmet are equipped with exhaust valves to minimize the possibility of blowup.

§ 1910.433 Breathing gas hoses.

(a) *Rating.* The employer shall confirm that breathing gas hose assemblies are designed for bursting pressures of not less than 4 times the maximum allowable working pressure at which they are to be used. Such hoses shall be marked with the maximum allowable working pressure. In no case shall the working pressure be less than the maximum depth of the dive (converted to pounds per square inch (psi)) plus 100 psi.

(b) *Properties.* The employer shall confirm that breathing gas hoses are resistant to kinking and capable of the required gas flow rates for the system used.

(c) *Testing.* (1) The employer shall test breathing gas hoses and fittings at least annually to 1.5 times their maximum allowable working pressure. In addition, they shall be tested after each exposure to rough usage or to other use which results in visible damage.

(2) Information concerning the tests performed on such hoses and fittings shall be entered in the equipment log in accordance with the requirements of § 1910.438.

(d) *Markings.* (1) The employer shall mark breathing gas hoses clearly in 10 ft. increments up to 50 ft. starting at the diver's end at 50 ft. increments thereafter, to enable the tender to determine how much hose has been payed out.

(2) Hose markings shall not be used as a primary method for determining diver depth. A pneumofathometer or similarly reliable and accurate method shall be used instead.

(e) *Corrosion resistance.* The employer shall confirm that breathing gas hose fittings used in salt water service are made of corrosion-resistant materials.

(f) *Design.* The employer shall confirm that the connections of breathing gas hose fittings are of a type that cannot be accidentally disengaged from the sections of hose or gas system.

(g) *Protection.* Employers shall tape, cap, or plug breathing gas hoses when not in use to prevent foreign matter from entering the hoses.

(h) *Oxygen cleaning.* The employer shall confirm that oxygen cleaning necessary to prevent ignition of materials within the breathing gas hoses when such hoses are placed in use is performed using appropriate cleaning agents. The cleaning process shall be described in the equipment log in accordance with § 1910.438.

(i) *Tagging.* The employer shall identify breathing gas hoses and fittings used in oxygen service by a tagging system or similar method.

§ 1910.434 Air compressors and systems for respirable air.

(a) *Volume tanks or receivers.* The employer shall confirm that volume tanks or receivers manufactured after the effective date of this subpart and used in compressed air systems for respirable air comply with the design and construction requirements of the current American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels. Tanks or receivers manufactured before the effective date of this subpart shall be maintained in conformity with the code requirements to which they were built. Volume tanks or receivers shall be equipped with a check valve on their inlet side, a pressure gauge, and a relief valve set to relieve at the maximum allowable working pressure on the volume tank or receiver.

(b) *Recording of maintenance and repairs performed.* The employer shall make an entry in the equipment log of all maintenance and repairs performed on the compressors and the air systems, in accordance with § 1910.438. These entries shall include such information as belt or oil changes on the compressor, any engine maintenance or repairs performed, or any other change or repair to any part of the air system, such as a filter change.

(c) *Air purity requirements.* The employer shall confirm that air supplied as a breathing mixture to a diver does not contain a level of carbon monoxide greater than 15 parts per million, or a level of carbon dioxide greater that 500 parts per million. The hydrocarbon content shall not exceed 5 milligrams per cubic meter, and the air shall not have any noxious or pronounced odor.

(d) *Air compressor intakes.* The empoyer shall locate air compressor intakes in an area free of exhaust fumes and other contamination. The air intakes of air compressors permanently installed in an enclosed space shall be piped externally to a source clear of exhaust fumes and other contaminants if an internal combustion engine is used as the prime mover.

(e) *Compressors.* The employer shall analyze compressor air output once every 1,000 operating hours or once every six months, whichever occurs first, to verify that the air discharge meets the air purity requirements of paragraph (c) of this section. A record shall be kept of

these readings in the equipment log in accordance with § 1910.438.

§ 1910.435 Pressure vessels for human occupancy (PVHO).

(a) *General PVHO requirements.* The employer shall confirm that pressure vessels for human occupancy manufactured after the effective date of this subpart conform to the requirements of the current ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels. PVHO's manufactured before the effective date shall be maintained in conformity with the code requirements to which they were built.

(b) *Oxygen piping on PVHO's.* (1) The employer shall confirm that all hard piping systems, fittings and tubing carrying pure, high-pressure oxygen are made of corrosion-resistant metals.

(2) PVHO internal oxygen outlets shall have non-return valves or shut-off valves.

(3) Shut-off valves used in an oxygen system above 125 psi shall be of the slow-opening type, such as a needle-type valve.

(c) *Installed oxygen breathing system.* On PVHO's with installed oxygen breathing systems, the employer shall provide adequate ventilation to prevent the oxygen concentration in the PVHO from rising above 25 percent.

(1) When ventilation is the sole method used, the oxygen concentration shall be continuously monitored.

(2) When an overboard oxygen dump system is used, the oxygen concentration shall be monitored at least once every 15 minutes.

(d) *Fire protection.* The employer shall confirm that PVHO's are designed and equipped to eliminate internal combustible materials and sources of ignition to the extent feasible.

(e) *Illumination.* The employer shall confirm that interiors of PVHO's are capable of being illuminated from the interior or exterior to permit visual observation of the diver from the exterior as necessary.

(f) *Exhaust line guard.* The employer shall install an exhaust line guard on the exhaust outlet inside the PVHO.

(g) *Audio-communication.* The employer shall confirm that an operating, 2-way audio-communication system is provided and used while a PVHO is in operation.

§ 1910.436 Depth gauges.

(a) *Testing and calibration.* (1) The employer shall confirm that depth gauges used in surface-supplied and bell diving and in the pressure system on PVHO's are deadweight tested or calibrated against a master-reference gauge every six months and any time there is reason to believe they are not functioning properly. A card or label shall be attached to the gauges showing date of test or calibration.

(2) An entry shall be made in the equipment log identifying the gauges tested or calibrated and describing the method used in accordance with § 1910.438.

(b) *Installation to allow checking.* The employer shall confirm that depth gauges in the pressure system on PVHO's are so installed as to allow a system check of their accuracy.

§ 1910.437 Compressed gas equipment (except SCUBA cylinders).

(a) *Securing of cylinders.* The employer shall store compressed gas cylinders in a well-ventilated area, protect them from heat, and secure them from falling.

(b) *Protection cap.* The employer shall keep the protection cap over the cylinder neck and valve of compressed gas cylinders when they are not in use.

(c) *Pressure regulator (oxygen).* The employer shall utilize oxygen-compatible pressure regulators to control flow in oxygen systems.

§ 1910.438 Equipment log.

(a) *Content.* The employer shall establish and maintain an equipment log in which at least the following information shall be entered:

(1) The procedures followed in testing gas supply hoses and fittings and the results of such tests;

(2) The procedures followed in the oxygen cleaning of hoses and the methods and materials used to maintain cleanliness;

(3) The maintenance and repairs to the air compressor and the air system;

(4) The testing and calibration of depth gauges;

(5) Any changes made to the design and operation of any equipment, device or system that change its operational air flow characteristics; and

(6) Air system air purity tests.

(b) *Entries.* For each entry in the equipment log, the employer shall identify the equipment or part, describe the nature of the work, note the date on which the work is performed, and require the individual performing the work to sign and print his name.

RECORDKEEPING REQUIREMENTS

§ 1910.440 Recording and reporting.

(a) *Recording.* The employer shall record occupational injuries and illnesses in accordance with the requirements of Part 1904 of this chapter.

(b) *Reporting.* (1) The employer shall report to the Area Director of the Occupational Safety and Health Administration, U.S. Department of Labor, the occurrence of any of the following employment-related accidents, injuries, or illnesses:

(i) Any fatality;

(ii) Any hospitalization of five or more employees;

(iii) Any diving-related injury or illness to any diver requiring hospitalization of 72 hours or more;

(iv) Any diving-related injury or illness to a diver requiring at least 5 days' treatment by an attending physicians; or

(v) Decompression sickness with residual audiovestibular or neurological effects.

(2) The employer shall report either orally or in writing within 48 hours after the occurrence. The report shall relate the circumstances of the accident, the number of fatalities, and the extent of any injuries or illnesses. The Area Director may require such additional report, in writing or otherwise, as he deems necessary concerning the accident.

§ 1910.441 Availability of records.

(a) *Inspection of records.* Upon the request of an authorized representative of the Assistant Secretary for Occupational Safety and Health, the employer shall make available for inspection and copying any manual, report, plan, record, log, table verification, PVHO oxygen concentration monitoring record, or document required by this subpart.

(b) *Retention of records.* The employer shall retain manuals, reports, plans, records, logs, table verifications, PVHO oxygen concentration monitoring records and documents required by this subpart for at least 3 years, except that the medical records required in § 1910.411 shall be retained for 5 years. This requirement shall not apply to the diver's log required in § 1910.422.

(c) *Transfer of records.* In the event the employer ceases to do business, the successor employer shall receive and retain all records required by this subpart.

APPENDIX A

RECOMMENDED BRITISH MEDICAL RESEARCH COUNCIL DECOMPRESSION SICKNESS REGISTRY TECHNIQUES SKELETAL RADIOLOGICAL INVESTIGATION FOR DIVERS

The basic skeletal survey should include views of the head and proximal parts of the shafts of the humerus and femur on each side and projections of each knee including the distal two-thirds of the shafts of the tibia.

The early demonstration of dysbaric osteonecrosis demands high quality radiographs which clearly demonstrate the bone trabeculae. This will require the optimum screen/film combination, an adequate ratio grid and focal spot size of 1 or 2 mm. A smaller size with a high-speed rotating tube should be used if this is available. Gonad protection should always be used. A list of recommended projections and specimen radiographs illustrating these views should be available for the radiographer. Where possible the radiographs should be checked before the patient leaves the X-ray room or Department and preferably this should be done by the radiologist responsible for the interpretation.

It is of considerable advantage to have the surveys done in as few centers as possible so that the radiography technicians become closely involved in the work and are fully aware of the problems in interpretation and the need for high quality radiographs.

SHOULDER JOINT

The objective is to obtain a radiograph of the entire articular cortex of the humeral head in unobscured profile. An 18 by 24 cm (8/10) film is recommended. An anteroposterior projection of each shoulder is taken with the patient lying supine and the trunk rotated to bring the scapula on the side to be radiographed flat against the table top. With the arm in the supine position (palm up), pulled down and abducted 10 degrees the beam is centered one inch (24.5 mm) below the tip of the coracoid process of the scapula. The beam should be collimated by bringing in the diaphragms to show only the

head and the proximal third of the shaft of the humerus. This view should show a clear joint space. The patient should hold his breath while the film is exposed.

HIP JOINT

The objective is to obtain a radiograph demonstrating the head of the femur. To obtain comparable radiographs at serial follow-up, the femoral neck should be in a standard position. A 24 by 30 cm film (10/12) is recommended. A separate anterposterior projection of each hip joint is taken with the patient placed in a supine position and the foot on the side under investigation kept at 90 degrees to the table top. The beam should be centered over the head of the femur, that is, 1 inch (24.5 mm) below the mid-point of the line joining the anterior-superior iliac spine and the mid-point of the upper border of the public symphysis. The beam should be collimated by bringing in the diaphragms to show only the head, neck and immediate subtrochanteric area of the femoral shaft. The edge of the gonad protector should be as near to the femoral head as possibit but not obscuring it.

KNEE JOINT

The object is to ensure a comparable density between the lower two-thirds of the femur and the upper third of the tibia. It is recommended that the kV is lowered, the mA raised and use made of a grid. Two projections are used. A 30 by 40 cm film (12/15) is recommended for both. An anteroposterior projection of each knee is made with the knee extended to include the lower two-thirds of the femur and the upper third of the tibia and fibula. The beam should be centered at the level of the upper border of the patella. A lateral projection of each knee joint is made with the patient rotated so that the lateral border of the knee to be examined is against the table. The opposite leg should be positioned so that a line through both anterior-superior iliac spines is at right angles to the table top. In this way the projection of the knee joint is more likely to be a true lateral. The field should include the lower two-thirds of the femur and the upper third of the femur and the upper third of the tibia and fibula. The beam should be centered at the level of the upper border of the patella.

If there is doubt about the diagnosis, the following additional views may be of value.

SHOULDER JOINT WITH ARM IN INTERNAL ROTATION

An 18 by 24 cm (8/10) film is recommended. An anteroposterior projection of each shoulder joint is taken with the patient placed in a supine position and the trunk rotated by turning the forearm to the prone position (palm down), with the elbow slightly flexed and the humerus abducted approximately 10 degrees. The beam is centered 1 inch (24.5 mm) below the tip of the coracoid process of the scapula. The beam should be collimated by bringing in the diaphrams to show only the head and the proximal third of the shaft of the humerus. The patient should hold his breath during the exposure.

HIP JOINT WITH LEG IN LATERAL POSITION

A 24 by 30 cm (10/12) film is recommended. A lateral projection of the hip joint increases the potential radiation close to the gonads. However, it may be of value in identifying an early lesion particularly when there is a structural failure with a translucent subcortical band. A separate lateral projection of each hip joint is taken with the patient supine. The knee and hip on the side to be examined are flexed so that the foot is flat on the table top directly opposite the other knee. The thigh is then abducted maximally and the knee supported by a sandbag. The beam is centered over the head of the femur, that is, 1 inch (24.5 mm) below the midpoint of the upper border of the public symphysis. The projection should include the head, neck and immediate subtrochanteric region of the femur.

FURTHER COMMENTS

The gonads must always be protected from ionizing radiation by a lead shield. If this is done, estimation of the radiation dose received by the patient indicates that the basic skeletal survey can be safely repeated at intervals of six months.

It is debatable whether the routine surveys should include the above-mentioned additional projections. However, when doing this type of work it is not always practical or easy to recall a man for a repeat or extended radiographic examination. In this situation it is worthwhile to include the additional projections as they may help to indicate more clearly whether or not an abnormality is present. If recall of the patient is easy, the survey should be confined to the basic views. Probably the greatest fault in the radiographs lies in underpenetration. The presence of osteonecrosis often results in an overall increase in bone bulk, so that there is more tissue for the X-rays to penetrate. Unless the kilo voltage is increased, possibly as much as 10kV above the normal value, a pale, underpenetrated radiograph will result. Underpenetration is one of the commonest causes of misinterpretation and failure to identify osteonecrosis, and care should be taken to avoid it. Other difficulties in interpretation arise from malrotation of the shoulder joint, which results in the superior border of the greater tuberosity appearing as a dense layer which could be misinterpreted as osteonecrosis.

Tomography may be required to improve definition particularly in the femoral head and sometimes in the humeral head where detail is obscured by overlying bone. In general, however, good quality radiographs preclude the need for frequent use of tomography.

PART 1915—SAFETY AND HEALTH REGULATIONS FOR SHIP REPAIRING

2. In Part 1915 of 29 CFR, § 1915.8 would be added to incorporate by reference Subpart T of 29 CFR 1910.

PART 1916—SAFETY AND HEALTH REGULATIONS FOR SHIPBUILDING

3. In Part 1916 of 29 CFR, § 1916.8 would be added to incorporate by reference Subpart T of 29 CFR Part 1910.

PART 1917—SAFETY AND HEALTH REGULATIONS FOR SHIPBREAKING

4. In Part 1917 of 29 CFR, § 1917.8 would be added to incorporate by reference Subpart T of 29 CFR Part 1910.

PART 1918—SAFETY AND HEALTH REGULATIONS FOR LONGSHORING

5. In Part 1918 of 29 CFR, § 1918.9 would be added to incorporate by reference Subpart T of 29 CFR Part 1910.

PART 1926—SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

6. In Part 1926 of 29 CFR, § 1926.605 (e) would be amended to incorporate by reference Subpart T of 29 CFR Part 1910.

[FR Doc.76-32625 Filed 11-4-76;8:45 am]

DEPARTMENT OF TRANSPORTATION

Coast Guard

[CGD76-009]

COMMERCIAL DIVING STANDARDS

Public Hearing

Pursuant to the Memorandum of Understanding between the Occupational Safety and Health Administration (OSHA) and the Coast Guard published in the FEDERAL REGISTER (41 FR 24292) on June 15, 1976, the Coast Guard intends to publish a notice of proposed rulemaking on commercial diving standards that will be substantially similar to the proposed permanent standards for commercial diving operations published by OSHA in the November 5, 1976, issue of the FEDERAL REGISTER (Vol. 41, Part V).

The Coast Guard and OSHA will hold a joint public hearing at 9:30 a.m. on December 16–17, 1976, at Terrace Suites 3, 4, and 5, Braniff Place Hotel, 1500 Canal Street, New Orleans, Louisiana, to receive public comments on the substance of the proposed standards.

Copies of the proposed OSHA standard may be obtained from the Executive Secretary, Marine Safety Council (G-CMC/81), Room 8117, U.S. Coast Guard, Washington, D.C. 20590 (202–426–1477).

The Coast Guard will give the public an opportunity to comment on its proposed regulations and will hold another public hearing if there is a substantive issue raised in the request for a hearing that was not or could not have been raised during the joint Coast Guard-OSHA hearing.

Dated: November 2, 1976.

W. M. BENKERT,
Rear Admiral, U.S. Coast Guard, Chief, Office of Merchant Marine Safety.

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